INTERAVIA

REVIEW OF WORLD AVIATION

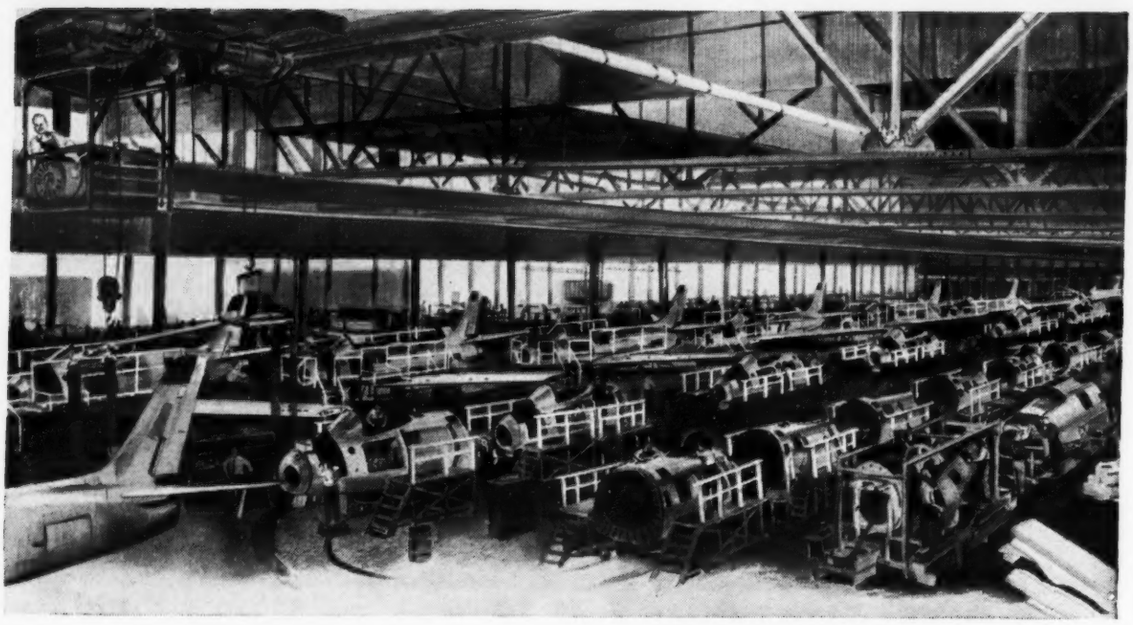
Price of this issue:

U. S. A.:	80 cents
British Isles:	5 s.
Switzerland:	Fr. 2.80
Netherlands:	Fl. 3.—
Denmark:	d. Kr. 5.—
Germany:	DM 3.—
France:	Fr. 250
Italy:	Lire 410

IN THIS ISSUE

Safety First

VOLUME VII 4 1952



HOW *Modern* IS CANADAIR?

Equipped to meet any challenge in aircraft production . . . the machine shops, foundry, assembly and engineering departments of this young Canadian plant are on a par in modern conception with any plant in the world.

The most advanced production methods are in operation . . . senior personnel have been drawn from the best sources throughout the globe . . . millions have been invested in the latest equipment . . . all meeting today's exacting demands of aircraft manufacture.

Here Canadair has produced many 4-engine airliners, is producing F-86* Sabre jets and preparing for quantity production of jet and conventional engine trainers . . . *Canadair is as modern as the planes she builds!*

For further information: European Representative, J. H. Davis, Princes House, 190 Piccadilly, London, W1, England.

Canadair

LIMITED, MONTREAL

* Made under licence from North American Aviation Inc.

Vignettes of
CANADA — AIR LAND

Canada has for years taken a lead in map-making by aerial photography and last year completed an entire air map of the country after 25 years of work. Recently new advances have been made by the Canadian Geodetic Survey in conjunction with the Royal Canadian Air Force. New techniques are now in use that permit precise measurement of distances of up to 300 miles and accurate pictures are taken at levels up to 35,000 feet. Also by the use of oblique and vertical photographs highly accurate maps on scales of 8 miles to the inch are now possible.
These advances are helping to speed the search for new natural resources and are typical of Canada's use of the air in her national affairs.

INTERAVIA

Review of World Aviation

Volume VII | No 4 | 1952

Board of Directors: Marcel Devaud, Edgar Primault, Eugen Groh, E. E. Heiman, O. H. C. Messner, E. V. D. Wight, Jr.
Editors: E. E. Heiman, P. A. Blackburn, E. Herzfeld.
Assistant Editors: H. Rieck, A. de Rham, J. Jenni, A. Arbex, E. Baur, Ginés de Bracamonte, J. M. Stroud.
Art Editor: H. W. Mahrer.
Publishers and Distributors: Interavia S. A. **Proprietors:** Volamecum S. A.

Contents

SAFETY FIRST

Safety in Air Transportation		183
Zero Ceiling, Visibility Nil...	G. FÉVRIER, PARIS	184
Safety and Equipment Policy	B. HOFFSTROEM, STOCKHOLM	187
Air Traffic Control - Air Traffic Safety	A. G. FISCHER, ZURICH	190
How to Make Yourself Understood - An ABC		194
The Maze of Accident Statistics	H. SCHREIBER, WINTERTHUR	196
Investigation of Accidents		197
Financial Safeguards for the Air Traveller	J. T. LACOUR, GENEVA	200
The " Swift " and INTERAVIA		202
Machine Tools for Defence		205
Fighters for NATO		211
Kloten's New Terminal Building		211
What's in the Air ?		212
Book Reviews		214
The Boundary Layer Fence	W. LIEBE	215
Radio Navigation Aids		218

Front Cover:

A heavy rain storm batters against the control tower windows at Cointrin airport, Geneva, but regular air services go on. A departing "Constellation" in the background leaves a "wake" behind.

Appears Monthly in Four Editions: English, French, Spanish and German.

Advertising Department, Publishing and Editorial Offices, Subscription Department: Interavia S. A., 6, Corraterie, Geneva. Telephone: 5 42 34 (five lines). Cables and Telegrams: Interavia-Geneva.

Annual Subscriptions: Switzerland, Sw. frs. 28.00; U. S. A. and Canada, U. S. $7.00; Great Britain, 40/—; France, Fr. frs. 2,400; Belgium, Belg. frs. 360.00; Holland, Fl. 31.00; Germany, DM 28.00; Sweden, Kr. 35.00; Norway, Kr. 50.00; Spain, Ptas 275.00; Austria, ö. S. 170. All other countries: Sw. frs. 28.00.

Agents and Distributing Offices:

INTERAVIA AUSTRIA:	Morawa & Co., Wollzeile 11, Vienna I.
INTERAVIA BELGIUM:	Office de Publicité, 16, Rue Marcq, Brussels.
INTERAVIA BRAZIL:	R. F. Besnard, 91 av. Almirante Barroso, S. 417-419, Rio de Janeiro.
INTERAVIA CANADA:	Wm. Dawson Subscription Service Ltd., 60 Front Street West, Toronto, Ontario.
INTERAVIA DENMARK:	Dansk Centralagentur, Stormgade 20, Copenhagen.
INTERAVIA FINLAND:	Akateeminen Kirjakauppa, Keskuskatu 2, Helsinki - Rautatiekirjakauppa Oy, Köydenpunojank 2, Helsinki
INTERAVIA FRANCE:	144, Champs-Elysées, Paris VIIIe.
INTERAVIA GERMANY:	Ausland-Zeitungshandel W. E. Saarbach, Gereonstrasse 25-29, Cologne 1. Postal Cheque Account Cologne 25823.
INTERAVIA GREAT BRITAIN:	Interavia (United Kingdom) Ltd., 2-5, Old Bond Street, London, W. 1.
INTERAVIA HOLLAND:	M. van Gelderen & Zn., Postbox 826, Amsterdam-C.
INTERAVIA IRELAND:	Basil Clancy, Esq., Cooleevin, Foxrock, Co., Dublin.
INTERAVIA HUNGARY:	Kultura, Akademia-utca, 10, Budapest, V.
INTERAVIA ISRAEL:	F. Pinczower P.O.B. 6008, Tel-Aviv.
INTERAVIA ITALY:	30 Via San Marino, Rome.
INTERAVIA NORWAY:	Narvesens Kioskkompani A.S., Box 125, Oslo.
INTERAVIA SOUTH AFRICA:	P. O. Box 6073, Johannesburg.
INTERAVIA SPAIN:	Litavia, Maestro Victoria 8, Madrid.
INTERAVIA SWEDEN:	Postbox 29, Linköping.
INTERAVIA U.S.A.:	385 Fifth Avenue, Room 1408, New York 16, N. Y. Subscriptions also from the International News Co., 131 Varick Street, New York, N. Y.

Copyright 1952 by Interavia S. A., Geneva, Switzerland

Printed in Switzerland

Imprimeries Populaires, Geneva — Héliographia S. A., Lausanne
Imprimerie de "La Tribune de Genève", Geneva

for **AIRCRAFT MAINTENANCE**

Overhauls
Repairs
Conversions
Conservation
Integral Tank Resealing

avail yourselves of the SAS' skilled technical staff and modern well-equipped hangars and workshops.

A qualified specialist is available for consultation at your base, and we shall have pleasure in discussing with you any aspect of your aircraft maintenance. Whatever the type of work - you can depend on

SCANDINAVIAN AIRLINES SYSTEM

DENMARK - NORWAY - SWEDEN

Region - Denmark Copenhagen Airport - Kastrup

What's Your Business,

Aviation?

It's Bendix International Business, too!

If you are in the aviation industry, *in any capacity whatever*, Bendix is an important factor in your life and your livelihood.

Look at the record. More planes fly more miles with Bendix radio equipment than any other make. Bendix ignition systems are virtually standard for the industry. Bendix has successfully solved fuel metering problems for every type of plane. Bendix is a foremost force in the development of equipment for automatic flight and all-weather landing.

And these are only the highlights of Bendix activities in aviation. Actually, no other single organization builds so many products essential to the safety and efficiency of modern planes. No other concentrates such a wide range of skills and talents on this industry's problems. As a result, none has a finer record of achievement in this ultra-progressive field.

The qualities which have won Bendix developments such broad acceptance in the exacting aviation industry are inherent in all of the more than 300 products which Bendix builds for industries of every kind. Some 4000 engineers and 14 research centers are constantly adding new devices to this list. Whatever you build, buy or sell, your own best interests suggest that you ought to know more about Bendix. Send for your copy of "This Is Bendix-International," without obligation, to:

STROMBERG FLOAT-TYPE CARBURETOR

BENDIX LANDING GEARS

BENDIX AIRCRAFT MAGNETOS

BENDIX SPEED DENSITY FUEL METERING

BENDIX AIR COMMUNICATION RADIO

BENDIX GROUND STATIONS

PACIFIC HYDRAULIC EQUIPMENT

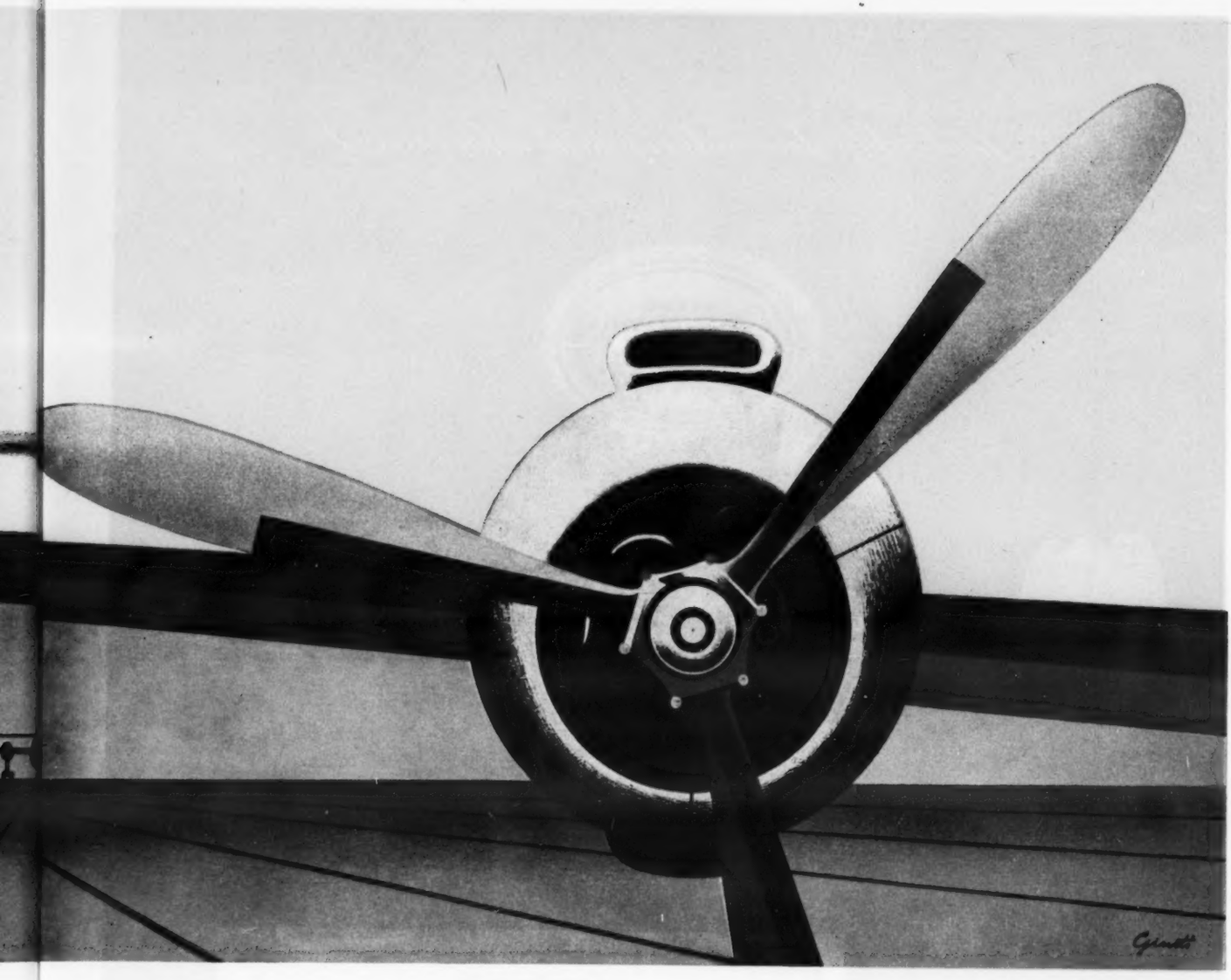
PIONEER FUEL FLOW TOTALIZER

SKINNER AIRCRAFT FILTERS

Bendix International

DIVISION OF BENDIX AVIATION CORPORATION

72 FIFTH AVENUE • NEW YORK 11, N. Y., U.S.A.



STROMBERG INJECTION CARBURETORS

BENDIX WHEELS & BRAKES

BENDIX IGNITION HARNESSES

SCINFLEX ELECTRICAL CONNECTORS

BENDIX JET IGNITION SYSTEMS

ECLIPSE JET ENGINE STARTERS

BENDIX GCA RADAR

BENDIX OMNI-RANGE EQUIPMENT

BENDIX TELEMETERING EQUIPMENT

BENDIX IGNITION ANALYZER

BENDIX AUTOMATIC PILOT

ECLIPSE STARTERS & GENERATORS

PIONEER AVIATION INSTRUMENTS

NATIONAL RADIO RECEIVERS

BENDIX FRIEZ WEATHER INSTRUMENTS

WEATHERHEAD AVIATION HOSE

REBAT AIRCRAFT BATTERIES

PIONEER SPECIAL ELECTRON TUBES

Leadership demands constant achievement

Lockheed Presents The

SUPER CONSTELLATION

An even finer version of the World's Most Experienced Airliner

Lockheed's new Super Constellation combines the unmatched record of experience and dependability of the world-famous Constellation with greater speed, greater range, greater comfort and greater size – unquestionably the finest airliner in the world.

Now in service for Eastern Air Lines and soon in service for Trans World Airlines, KLM Royal Dutch Airlines, Air France, Pakistan International, Qantas, Trans-Canada Air Lines, Seaboard & Western Airlines, Braathens S. A. F. E. Air Transport and other leading airlines.

LOCKHEED

AIRCRAFT CORPORATION, BURBANK, CALIF., MARIETTA, GA., U.S.A.

Lockheed

SUPER CONSTELLATION ASSURES MANY YEARS OF COMPETITIVE PERFORMANCE

Compared with any of today's certificated aircraft the new Super Constellation is superior in versatility, speed, pay-load, range and ability to earn profit.

The Super Constellation offers a special 97 passenger interior that is quickly converted to a standard luxury interior for 59 passengers capable of a 3900 mile over-ocean flight with normal airline fuel reserves. It is the first transport designed to use compound engines. With this modern power (3250 horse power engines) it has a maximum speed of 375 miles per hour, a cruising speed of 340 miles per hour, maximum take off weight of 130,000 pounds and maximum landing weight of 105,000 pounds.

Compared with the original Constellation, this much enlarged version offers a 30 per cent increase in power, a 19 per cent increase in length, a 24 per cent increase in gross weight and 67 per cent more cargo space.

Easy conversion to Turbo-Propeller Power

Further proof of the Super Constellation's growth factor is its capability of conversion to turbo-propeller engines with minimum modifications. No structural changes of the empennage, fuselage or basic wing are necessary. Never before has the basic structure of any aircraft provided so adequately for continuing modernization.

Air cooling equipment engineered for the new Super Constellations will have a comfort capacity from 50 to 400 per cent greater than any other airliner. While on the ground at airports passenger cabins can be kept at 75 degrees Fahrenheit when the outside temperature is 100 degrees. Heating equipment will maintain 75 degrees Fahrenheit in the plane when it is 60 degrees below zero outside. Pilot's quarters are similarly comfortable.

World's Largest All-Cargo Commercial Transport

As an all-cargo transport the Super Constellation is the largest produced for commercial use. It has a 38,800 pound maximum pay-load and will cruise up to 335 miles per hour, depending on load and range. Its main cargo compartment is 84 feet long, longer than 2 standard American railroad freight cars. Total cargo volume is 5,568 cubic feet. It has special one-man loading equipment, including optional built in electric floor conveyor for moving heavy cargo. *Operating cost is the lowest in air cargo history — less than 5 cents per ton mile.*

No other modern transport offers so great a combination of advantages.

To and from ROME

Egypt
Eritrea
Somaliland
Libya
Greece
Lebanon
Portugal
Venezuela
Portugal
Brazil
Argentina

Fly

ALITALIA

ALITALIA'S four-engined "SUPERMASTERS" offer an unsurpassable free bar and restaurant service with first-class Italian cooking and vintage wines. Free air mail — All the comfort of your own home.

Once you have flown ALITALIA you will always fly ALITALIA

All information from your travel agency,
ALITALIA
agency or head office

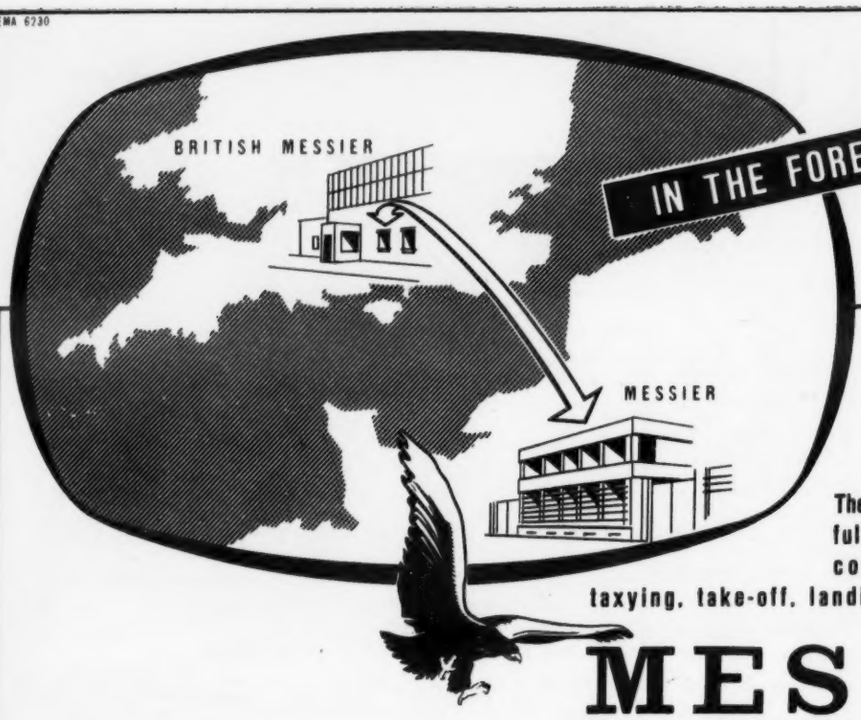
20, Via Bissolati
ROME

M.S 733

THE MOST UP-TO-DATE OF TRAINERS

MORANE-SAULNIER

PEMA 6730

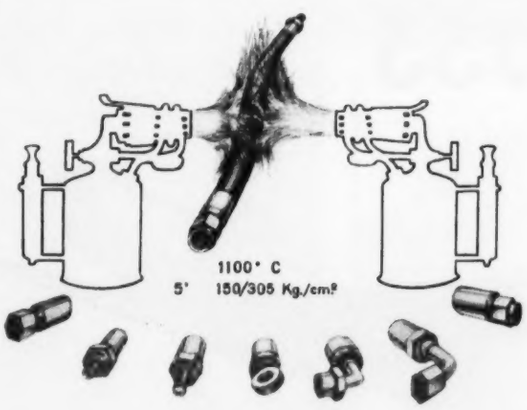


IN THE FOREFRONT OF PROGRESS

The only firm in the world which takes full responsibility for all aircraft components concerned with taxying, take-off, landing and braking.

MESSIER
the undercarriage specialists

MESSIER, 58, RUE FENELON, MONTROUGE (SEINE) - TÉL. : ALE. 22-36
BRITISH MESSIER LTD - CHELTENHAM ROAD EAST - GLOUCESTER



ITALA

FABBRICA TUBI FLESSIBILI
SOMMA LOMBARDO (VARESE)
ITALY

20 YEARS OF RESEARCH, EXPERIMENT AND TESTS

- Low, medium and high pressure flexible tubes for oil, fuel, gas etc...

IGNI-FRIGORESISTENTS

- All jointings recognized by civil and military aviation, others on request.
- All tubes tested by Italian air engineers and Air Registration Board according to rules in force for

Pressure, resistance to oil, vibration, pulsation, resistance to flame.

- Temperature range in use : 150° C to —45° C.
- Pressure resistant. Breaking load 14,220 psi.
- Electric cables with cotton covering impregnated with coloured varnish, or with metal sheath, for all aircraft uses.
- Suppliers to the Italian Army, Navy and Air Force.

ON THE PRINCIPAL ROUTES OF
AIR FRANCE

you will travel by "CONSTELLATION"
"the Atlantic favorite"

To all seasoned air travellers the name "Constellation" has come to symbolize reliability, speed and comfort.

For several years Air France's every effort has been directed towards offering all its passengers on long-distance services the privilege of travelling by this wonderful aircraft.

Today Air France is proud to be able to announce that this result has been achieved on all its major international services.

You can go by Constellation

To South America : Recife, Rio, Buenos Aires. To Africa : Dakar, Konakry, Duala and to Madagascar. To the principal cities of Europe and the Near and Far East. Finally between Paris and New York you can enjoy the added comfort of a sky lounge chair.

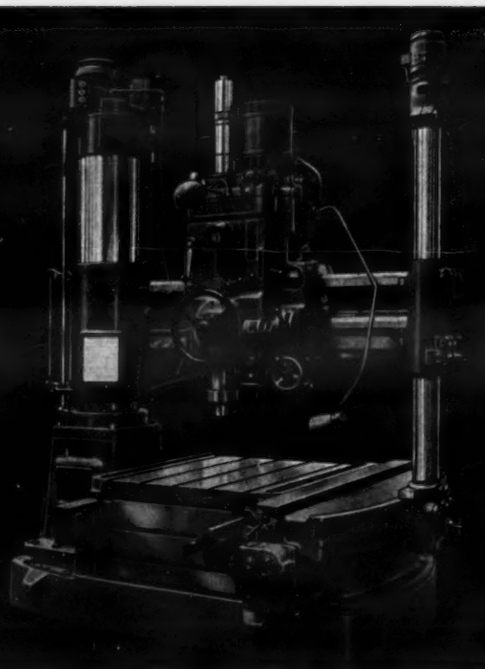
AIR FRANCE

ALL TRAVEL AGENCIES AND 119 CHAMPS-ÉLYSÉES - BALZAC 70-50 - 2 RUE SCRIBE - OPÉRA 41-00

These figures speak for themselves :
In 1947 : 423,115 passengers
In 1950 : 774,906 passengers
In 1951 : 1,000,000 passengers

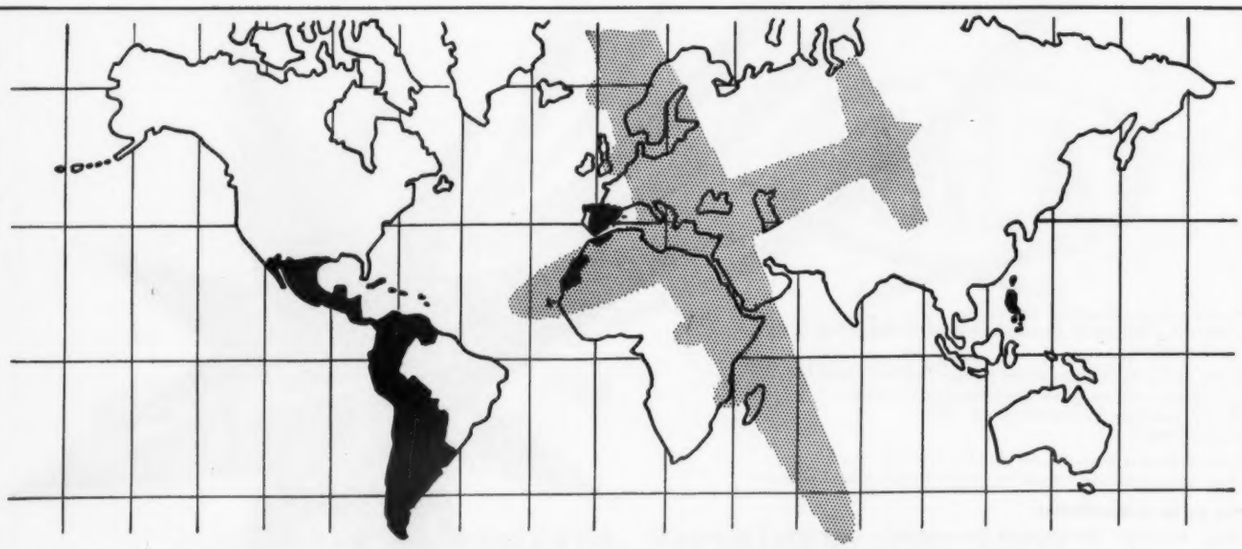
J-233

HIGH SPEED LATHES
PRODUCTION JIG BORERS
UNIVERSAL DRILLING MACHINES
STRAIGHT-BEVEL-GEAR PLANERS
SPIRAL-BEVEL-GEAR GENERATORS
MILLING MACHINES
FORM AND CUTTER GRINDING MACHINES
CARBIDE TOOL GRINDING MACHINES



OERLIKON

OERLIKON MACHINE TOOL WORKS BUEHRLE & CO.
ZURICH-OERLIKON SWITZERLAND



Over 120 million people speak Spanish!
You can reach them on the aircraft of

I B E R I A
LINEAS AEREAS ESPAÑOLAS

From Madrid to : Buenos Aires, Caracas, Porto Rico, Havana, Mexico, Paris, London, Geneva, Rome, Lisbon, Canaries, Tangier, Spanish Morocco and the whole of Spain.

the world's greatest parachute manufacturing facilities

Mental and mechanical

Check the history of the parachute... as a lifesaving device . . . as a safe method of landing paratroops . . . as a drop for large and small cargo . . . as an "air brake" for jet planes and as an assist in their maneuvering . . . at every point in the development of the modern parachute, and you'll find that Pioneer Parachute Company's contribution stands out front. In engineering, research and development . . . in testing and in manufacturing . . . the Pioneer Parachute Company, in conjunction with Cheney Brothers, has put together the world's greatest parachute manufacturing facilities—both mental and mechanical. Whatever the application . . . whatever the special requirements . . . Pioneer has the facilities for perfecting and manufacturing parachutes through every step, from the weaving of the cloth to the packing of the finished parachutes . . . the finest quality, produced in quantity and delivered on schedule.

PARACHUTES MAKE THE DIFFERENCE!

PIONEER PARACHUTE COMPANY, INC.
MANCHESTER, CONNECTICUT, U. S. A.
CABLE ADDRESS PIPAR, Manchester, Conn. U S A

Switzerland : RIWOSA S.A. — Witikonerstrasse 80 — Zurich 32, Switzerland
Holland and Denmark : Schreiner & Company — 24 Javastraat — Den Haag, Holland
France : M. Guy Robert — Equipements d'Avions & d'Aérodromes — 11 Rue Tronchet — Paris 8, France
Turkey : Mr. Affan Ataceri — 69 Adakale Sokak — Yenisehir, Ankara, Turkey
Belgium : Benelair, Ltd. — Rue de la Loi 114 — Brussels, Belgium
Sweden and Finland : Mr. Ake Forsmark — Kummelvagen 9 — Alsten — Stockholm, Sweden
Norway : Wideroe's Flyveselskat A.S. — Kr. Augustsgt. 19 — Oslo, Norway

SOCIÉTÉ D'EXPLOITATION DES MATÉRIELS

HISPANO SUIZA

RUE DU CAPITAINE GUYNEMER - BOIS-COLOMBES - SEINE

JET ENGINES
AIRCRAFT ENGINES
DIESEL ENGINES
ALUMINIUM FOUNDRY

Sole agents in France for **ROLLS-ROYCE** *(Aviation)*

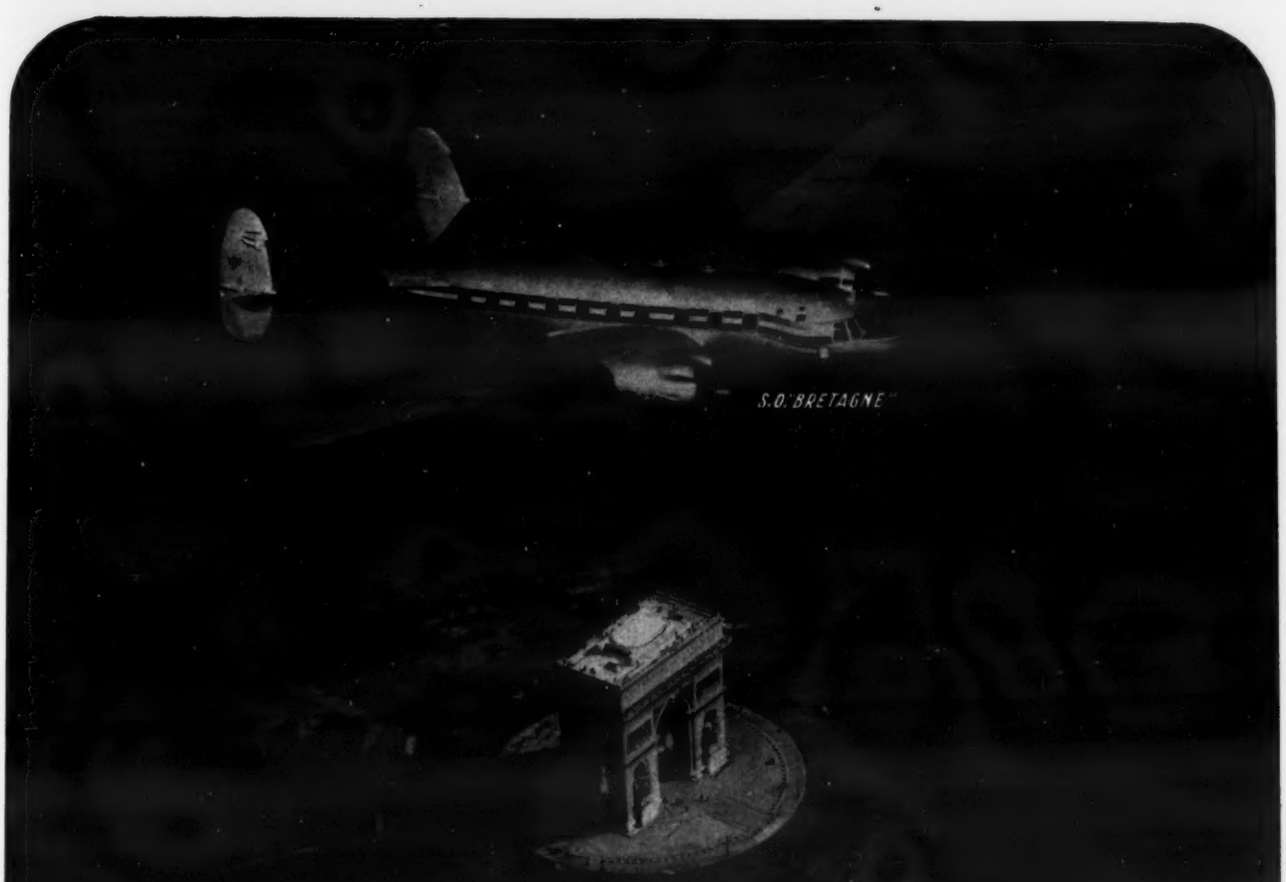
BY SABENA

ADD IT UP...

and you will find that by SABENA your time is employed to the maximum advantage and that you cut out unnecessary expense which can be so costly by other forms of transport.
Besides, your ticket is cheaper than you think... and don't forget that during flight you enjoy delicious hot meals served by the Flying Chef, and excellent wines from the cellars of SABENA, all at no extra cost.

NO WASTE

Ask your Travel Agent for details and you'll be convinced



CLICHÉ L. P.V.A.

S.N.C.A.S.O

AVIONS DE TRANSPORT

AVIONS MILITAIRES A RÉACTION

HÉLICOPTÈRES A RÉACTION

SOCIÉTÉ NATIONALE DE CONSTRUCTIONS AÉRONAUTIQUES DU SUD-OUEST

105, AVENUE RAYMOND POINCARÉ, PARIS 16e

RADIOELECTRIC ALTIMETERS
with enclosed aerials
AERODROME GONIOMETERS
RADIO COMPASS
(light-weight, accurate)
BAD VISIBILITY RECEIVERS
DECCA NAVIGATOR
with Flight Log
RADAR

sécurité aérienne

SFR

radiocommunications

HERTZIAN CABLES
TRANSMITTERS OF ALL POWERS
TRAFFIC RECEIVERS
MOBILE STATIONS
ELECTRONIC TUBSS
QUARTZ AND FILTERS

SOCIÉTÉ FRANÇAISE RADIOÉLECTRIQUE
SOCIÉTÉ ANONYME AU CAPITAL DE 620.000.000 DE FRANCS
79, BOULEVARD HAUSSMANN - PARIS (8E) - TÉL. : ANJ. 84-60

Safety First

Safety in Air Transportation

The Lausanne-Geneva express was racing along beside Lake Geneva at 75 m.p.h. My travelling companion was attentively reading his evening paper, which contained a vivid account of a serious railway accident in America. The man went on smoking his cigar quite unconcerned. It did not seem to occur to him that he too was sitting in an express train.

A few days later I was again in the train. In my compartment there was an American couple who were just finishing their first trip to Europe. In a few days' time they were leaving for home again . . . but not by air. The young wife reminded her husband of the recent accidents at Elizabeth, and decided that of course they must go back by the Queen Mary. As if there had never been any shipping accidents . ..

The subject is a delicate one. However, nothing is to be gained by going round it in circles.

The travelling public is told that air travel is 100 percent safe. The expert waves all objections aside, and the air transport authorities happily produce statistics involving millions of passenger-miles . . . Then suddenly there is some great disaster which the passenger is expected to swallow without turning a hair. Between December 16th, 1951, and February 11th, 1952, i.e., in under two months, there were three air accidents in the American town of Elizabeth, with a total of 118 deaths. And then the airlines are surprised that the anxious wife should persuade her husband not to fly, and the worried air traveller should decide to use the train for a time.

There's something wrong with present-day air travel publicity. Have you ever seen railway or shipping brochures using statistics to give the public a *feeling of safety ?* Safety is taken for granted by both the operator and his customers, although absolute safety of course does not exist. The publicity experts quote hundreds of millions of passenger miles at the air traveller to give him the same feeling of safety. He may not even know what a passenger mile is, and certainly does not want to know whether he is likely to be the unlucky *n*th person to prove all their calculations right.

What is the reason for all this ? Firstly, the fact that air transport is the newest form of transport. Then it has in the past permitted itself the luxury of asking very high prices, so that it has remained a mode of travel for the privileged few. When a railway train runs off the rails, the victims are unknowns. If an aircraft crashes, there is almost sure to be a junior minister, a famous artist or a champion boxer on board. The unknown railway passenger is mourned only by his family. Tributes to the minister, the singer or the boxer fill whole columns in the newspaper.

This will doubtless change : In the summer of 1952 air fares are being reduced, Smith and Jones will be able to fly, and the aircraft will eventually become the means of transport for the common man. All forms of transport have their accidents, particularly the more popular ones. Eventually then we shall be able to dispense with superfluous statistics, and the public, although continuing to deplore them, will learn to accept air accidents, like railway, shipping or road accidents, as an unavoidable evil.

If we must have publicity for safety, why not the kind the public can understand ? Let us list some of the serious transport accidents of 1951. The list makes no claims to be complete or accurate. It is merely intended to show that everywhere—air transport too had over 40 million passengers during 1951—it is the same story.

What is the object of serving up this mournful news again ? Merely to remind ourselves that all forms of motion—and modern transport is a particularly rapid form of motion—have their risks. Everything that is humanly possible is being done day by day, by transport companies, industry and authorities, to avoid these risks.

One thing is certain, however. A man who reads about a bus accident one morning will quite unconcernedly get into a bus himself ten minutes later. And the same man, if he hears about a railway accident just before leaving on a train trip, will buy his ticket and set out quite happily.

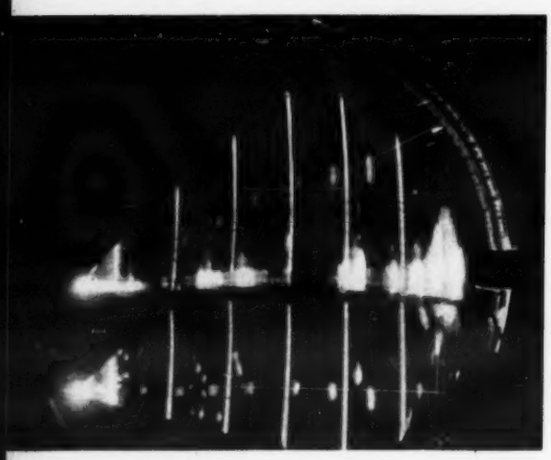
That's how it must one day be in air transportation.

		Air transport		Rail, road, ship
January			21st	Shipping accident near Yokohama; 60 dead.
February	2nd	Accident in Iceland ; 20 dead.	7th	Railway accident on New Jersey Bridge (USA); 81 dead.
		Accident near Brazzaville (Africa); 35 dead.		
March	25th	Accident near Azores ; 53 dead.		
April	26th	Accident in Florida (USA) ; 43 dead.	21st	Shipping accident in Gulf of Mexico ; 38 dead.
			24th	Railway accident in Japan ; 97 dead.
May			14th	Railway accident in India ; 24 dead.
			15th	Ships in collision off Cape Henry (USA) ; 36 dead.
			18th	Ship explodes off Saigon (Indo-China); 55 dead.
June			3rd	Bus accident near Brescia (Italy); 12 dead.
July	1st	Air accident near Colorado (USA); 50 dead.	1st	Bus accident in Mexico; 50 dead.
	15th	Air accident near Sergipe (Brazil); 31 dead.		
August	25th	Air accident in California ; 30 dead.	14th	Bus accident by Lake Rezi (Persia); 35 dead.
			20th	Accident to steamer "Dronio"; 28 dead.
			24th	Railway accident near Metx ; 21 dead.
September	9th	Air accident near Rio de Janeiro ; 28 dead.	1st	Bus accident in Persia ; 29 dead.
			13th	Bus accident in Colombia ; 28 dead.
			21st	Railway accident in England ; 20 dead.
			22nd	Railway accident near Rio de Janeiro; 21 dead.
			26th	Railway accident near Langenbank (Austria) ; 19 dead.
October	29th	Air accident in Guatemala ; 28 dead.	7th	Railway accident near Caldas (Cordilleros); 26 dead.
November			13th	Railway accident near Wyoming (USA) ; 27 dead.
December	17th	Air accident near Elizabeth (USA); 56 dead.	5th	Bus accident in England ; 23 dead.
			18th	Railway accident in Brazil ; 34 dead.

Safety First

Zero Ceiling, Visibility Nil...

BY GEORGES FÉVRIER, PARIS



The upper half of this Precision Approach Radar scope of a GCA installation shows the side view and the lower half the plan of the approach route to the instrument runway. Vertical lines mark the distance from the touch-down point in miles; points of light show the position of the aircraft; the light patches in the centre of the scope are reflections from ground obstructions.

Radar is the greatest single contribution to the safety of flying of recent years. Thanks to the magic radar screens any pilot worth his salt can put down his aircraft even under critical weather conditions—provided that he agrees blindly to obey the orders of the GCA controller. If he does so, he can even land at fields with which he is not familiar.

Need I mention the three "Meteor" fighters which were "talked down" wing-tip to wing-tip at Brussels a few weeks ago? Or the "Tornado" four-jet bomber which, en route to England, was running out of fuel over the Paris region and decided to land at Orly? After two unsuccessful attempts —one off course and the other at a speed of 280 m.p.h.—the "Tornado's" skipper announced calmly:

"I shall make a last attempt. If I fail, we shall climb to 8,000 ft. and bail out..."

He did not fail, and his aircraft did not crash into the tightly packed houses of Paris.

Even well-informed passengers sometimes feel misgivings when their aircraft, directed by GCA, dives into the murky fog. In the cockpit, where the Voice calmly issues its orders, where the unseen presence of the GCA controller *who can see you* acts like a guardian angel, such emotions are unknown—for modern radar inspires absolute confidence. Were this not the case, veteran pilots would never agree to surrender their own will and their own power of decision to the scanner of a radar scope.

A description of an actual GCA let-down follows. Apart from a few intentional inaccuracies (F-BFVI is not a four-engined transport, it was not flying from the USA, and even if it had been it would no doubt have landed at Orly rather than at Le Bourget), this record of a GCA landing, resembling dozens of others, is absolutely correct.

... The hours have passed ...

Under the wings of F-BFVI dense clouds spread to the horizon without a break, looking like a surface of cotton-wool thick enough to land on...

Near the end of the trip. All that is needed now is the touchdown. But conditions are unfavourable everywhere. Low cloud base at London, Brussels, Paris, Geneva, visibility almost zero. For the last few hours we have been bucking a 68-mile headwind which has greatly increased our fuel consumption. Soon we shall *have* to land.

In the main compartment everything is calm. The passengers read, talk or sleep. One of them jokes with the air hostess, who has just brought him another whiskey. The aircraft is high above the clouds, the sun is shining, the big transport glides along at 300 miles an hour, like a winged arrow. Everything is under control.

And up front, in the cockpit?

... *The field is closed, sir,* the tower at London Airport said a minute ago—echoing Brussels, Amsterdam.

Lyons? Closed. Geneva? Closed.

Closed. CLOSED. CLOSED.

The skipper turns to his crew.

— *Gas?*

— *Two hours and a quarter.*

— *Position?*

— *Five miles north-west of Cherbourg.*

— *Call regional traffic control. Ask them how things are at Le Bourget.*

Ceiling 150 feet, visibility 1,500 feet. Closed everywhere. Yesterday probably our number would have been up. Today...

On the other side of the door marked "No Entry" the usual end-of-a-trip rites are in progress. Cards are being exchanged, the last glass of champagne is being emptied. We shall meet again, we shall write...

... while under the grey, massive wings of F-BFVI the never-ending cotton-wool stretches beyond the horizon.

— *Miss, what time are we due to land?*

— *Just a moment sir, I'll ask the Captain.*

— *Landing? In about ten minutes, sweetheart...*

In order to be able to hear the question the pilot pushes up his earphone for five seconds, and when he replies he shuts off his microphone. The customer is always right! Even when the ceiling is less than 150 feet, visibility less than 1,300 feet, even when there is fuel for less than an hour in the tanks. Even when a pilot with 10,000 flying hours and 3,000,000 kilometres in his log is about to surrender his own free will, to eliminate his own reflexes and to entrust his life, the lives of his comrades and of his 40 passengers, as well as the million-and-a-half dollars represented by his aircraft, to a nameless GCA controller who, seated in solitude before his radar scopes, will order the pilot to carry out manoeuvres which he himself has never attempted and could never hope to achieve successfully. And the veteran pilot will have no chance to argue, let alone disobey...

Yesterday this pea soup would have meant disaster, today it means a GCA landing.

The Air Hostess is back in the cabin.

— *We shall be landing in ten minutes, sir. Ten minutes or thereabouts.*

— *But that means we shall be late.*

— *Oh, five minutes at the outside. The weather isn't so good in Paris...*

Reassured the customer says: "Thank you," leans back in his comfortable seat. Ten minutes more to sleep.

Up front, in the "office," there's no sleeping.

— *F-BFVI, Foxtrot, Victor, India calling Bourget tower. Foxtrot Victor India asking for a GCA landing. Over.*

— *Bourget tower to Foxtrot Victor India. GCA landing authorized. Contact Bourget GCA on 119 decimal 5 megacycles. Over.*

— *Foxtrot Victor India to Bourget tower. Received and understood. Shall contact Bourget GCA on 119.5—wun wun niner decimal fife...*

". . .There he is, the little controller, a man like any other . . . a man with eyes tired from watching the green pips on the screen."

Now the big transport is in the middle of the "soup." The cotton-wool streams over the wings, the tips of which are invisible. Every man of the crew is at his station, earphones in place, listening.

They are listening to the Voice which is to guide them, the Voice which is to give orders to the commander. The Voice has begun to speak.

— *Bourget GCA. I read you five by five.*

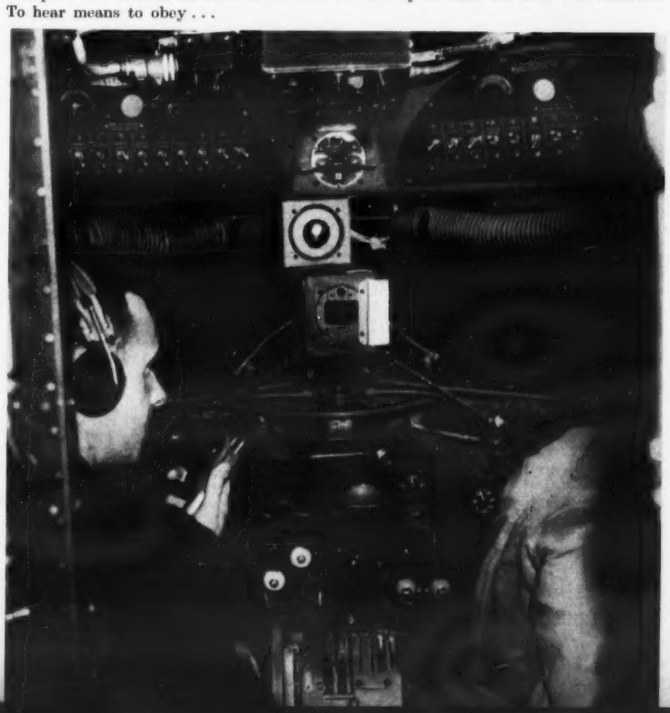
The Voice? It is the little GCA controller. There he is, in a room 10 foot square, a dark little room in which he sits perspiring, ruining his eyes watching the radar scopes. He sits on a wooden bench, like a school boy. He mustn't think of his sick wife, or his kid's bad school reports, or the rent that's waiting to be paid. He must think of nothing but of Foxtrot Victor India and of the forty-four lives depending on him.

There he is at his station, a man like any other, with a cold or a pimple. A man with eyes tired from watching the green pips on the screen. A man with worries and troubles like everyone else.

Like anyone else ? No, now he becomes a god and presides over life and death. The success of the landing depends upon his ability alone, on his concentration and his experience. It is he who will translate for the blind occupants of Foxtrot Victor India what the magic eyes of radar can see through night and fog.

Where is Foxtrot Victor India ? There, on the screen, a small green pip lights up gradually, second by second. It traces the course of an aircraft, one of many, the twenty-eighth the little controller will have "talked down" today.

The pilot has become an automaton who will merely execute the orders he receives. To hear means to obey . . .



Will he be in time for his Metro connection at Villiers, the little controller ?

— *Bourget GCA calling Foxtrot Victor India. I now have you on the scope. You are two kilometres from the cone of silence. What is your course ? Over.*

In the small dark room, where the air is always sticky, where green flashes sweep across the screens second by second, Foxtrot Victor India speaks in turn.

— *Received and understood. Two kilometres from the cone. My course is 270.*

Too bad for that Metro connection, too bad for the dinner that will be spoiled, too bad for the kid worrying over his homework. The only thing that matters now is the small green spot, Foxtrot Victor India . . .

— *Correct your heading twenty degrees to port. Take course two fife zero. You are now one kilometre from the cone. Your cockpit check should be completed. Wheels down and locked . . . adjust your bearing indicator and don't touch it again. Over.*

— *Foxtrot Victor India to Bourget GCA. Received and understood. One kilometre from cone. Heading two fife zero.*

The wheels have been lowered. The aircraft continues to fly in the thick fog. The dot-dash of the A and dash-dot of the N have merged

His right hand holds down the button which works the antennas 4000 yards away ; his tired eyes follow the green pip . . .

into a long continuous whine in the earphones. Then silence. Switch to VHF. The orange light begins to glow.

The Voice resumes :

— *Bourget GCA to Foxtrot Victor India, you are now over cone of silence. Prepare for final let-down. Remember that your speed and flap angle are at your own discretion . . .*

Flaps ? Engines ? Propeller pitch ?

In reply to each question the flight engineer gives a thumbs-up signal with his right hand, everything is under control . . . So far as the passengers are concerned the trip continues : the aircraft is still in flight. Just as before.

The Voice continues :

— *If you lose radio contact with Bourget GCA, you will recontact Bourget tower. Approach on 119.5 megacycles. Do not answer.*

In the cockpit the pilot has put away his microphone. He is now a mere automaton who will execute the orders he receives. To hear these orders means to obey them. Feet and hands automatically translate what the eyes read on the compass and the rate-of-descent indicator into what the Voice tells them to do . . .

— *Bourget GCA to Foxtrot Victor India. You are now eight kilometres from the touchdown point which is one eight zero metres from the runway head. Start letting down at fife zero zero feet per minute.*

At more than eight feet per second, on course 250, F-BFVI comes down and down and down.

On the radar scope the green pip moves along. It takes a lot of concentration to follow it and not lose it among the spots produced by the radar echo from fixed obstacles. There is no time to think about the heat in the small room, about one's ailing wife or the fact that one's income tax forms must be filled in before midnight.

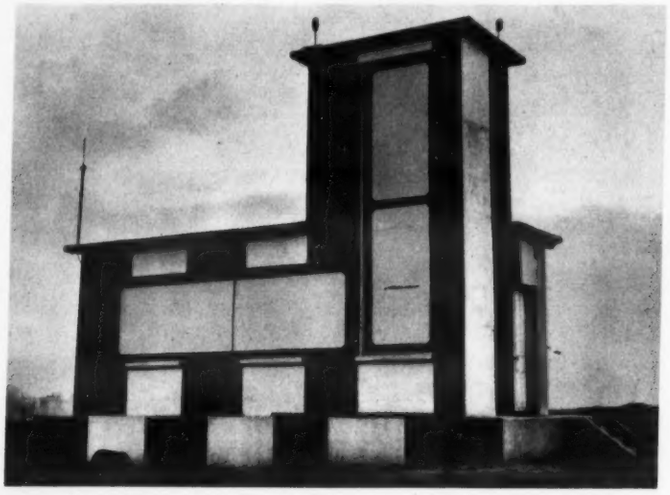
Ceaselessly, second by second, indefatigably, the green pips move across the screen. And the little controller is talking all the time.

— *You are making a good let-down and are now six kilometres from the touchdown point. You are deviating to port. Correct your course two degrees to starboard. Heading 247 . . .*

In the cockpit, the compass turns slowly : 248, 247.

And without interruption the Voice continues, monotonously :

— *You are now ten metres too low. Flatten out a little and get back on to the glide path. Correct your course another two degrees to starboard. Take heading two four niner . . . you are now gradually coming back to the glide path. Resume your normal rate of descent. You are now fife kilometres ahead of the runway . . .*



The passenger has no time to see the little red and white building at the end of the runway, where the life-saving radar is housed . . .

Four kilometres, three kilometres, two kilometres . . . The right hand firmly pressing the button which actuates the antennas 4,000 metres away, the tired eyes of the little controller follow the green pips which now seem to race from one sector of the screen to the next. Kilometres are nothing at a speed of 200 an hour.

— *You are making an excellent approach. You are now two kilometres from your touchdown point . . .*

On the radar screen the green pips move downwards along the glide path line and along the runway centre line . . .

— *You are now crossing the approach line. You are fife metres below height. You are approaching the beginning of the runway. You are descending normally and are now one kilometre from the runway, slightly to port . . . A slight correction to starboard . . . Fife zero zero metres from the runway . . . Now you are over the runway . . . Touch down.*

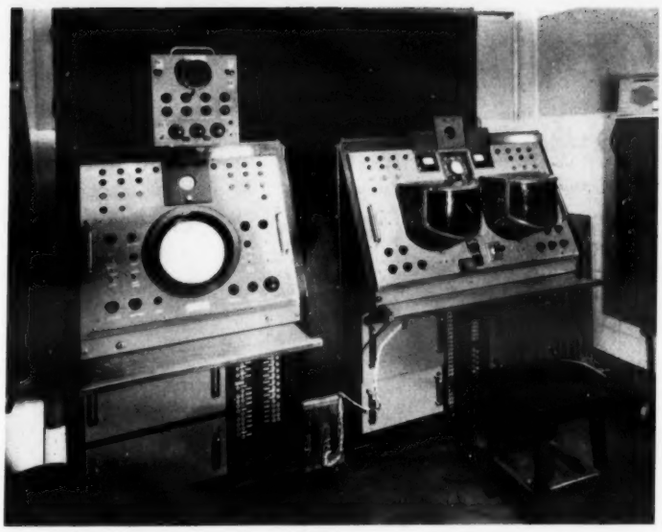
As if by a miracle the runway is there. The wheels hit the concrete, the aircraft races along under the dark, menacing sky which had threatened to send it to its doom. It is taxying along on the good solid earth . . .

In the cabin the well-informed passenger pulls out his watch. He holds it up to the Air Hostess and says severely :

— "*You see, Miss, we are three minutes late !*"

He didn't have time to see the building which houses the robots near the entrance to the runway, the small red and white structure holding the radar antenna.

In his cramped quarters—ten feet by ten, in the heat and the dark—the little controller straightens up his tired back. He has just talked down his twenty-eighth. The lights on his radar screens are extinguished



The GCA controller has brought in his 28th aircraft . . . The radar screens are switched off . . . At last he is free . . .

and he puts down his headphones and microphone. He is free at last.

. . . Free to think of his wife, of his Metro connection, of the shoes that are pinching him and of his kid whom he will find in tears.

The god has become a man again.

Author's note

I wish to thank Messrs. Couhé and Lesieux, Chairman and Director General of Paris Airport, respectively ; Monsieur Bocquet, Commandant of Le Bourget Airport and his assistant, Monsieur Sommessous ; Monsieur Constantinovitch, in charge of GCA and other landing aids at Le Bourget ; Monsieur Serre, the airport's photographer, as well as Cie. Française Thomson Houston . . . without whose collaboration this story could not have been written.

. . . My thanks also to Monsieur Dubosc, pilot of Foxtrot Victor India, who was carrying no passengers apart from . . . *G. F.*

. . . or the radar antennas.

Safety and Equipment Policy from an Airline Viewpoint

BY BO HOFFSTROEM,

DIRECTOR OF PROJECTS AND DEVELOPMENT, SCANDINAVIAN AIRLINES SYSTEM, STOCKHOLM

The interrelation between an airline's flying safety record and its equipment policy is not as simple and direct as one might believe at first sight. There are major factors contributing to air safety other than equipment, for example personnel training, schedules, flight operation procedures, system intercommunication and flight dispatch set-up.

Equipment policy, here taken to include maintenance and handling policies as well as choice and adaptation of equipment, forms a part of an airlines' management planning that inherently carries a great deal of "inertia." Maintenance policy is invariably connected with bases and buildings, and any major change thereof necessarily involves redisposition of investments and time-consuming construction programmes. Commitments for new flying equipment often have to be made two or three and sometimes five years ahead of its full operation, and replacing part of the fleet at short notice simply is not possible.

Consequently, its equipment policy in a broad sense most significantly determines the character of an airline. But how does it actually reflect on its safety of flying ?

It would not be correct to say that any equipment policy could cause a material deterioration in an airline's flying safety record. Long before any such thing could happen, other actions would be taken to offset this trend. The most obvious and drastic thing to do, if the accident record tends to become unsatisfactory, is to stop flying. A grounded fleet is actually the ultimate consequence of a bad equipment policy. Considering that one single, modern 60-passenger airliner generates some $50,000 gross revenue every week, it is obvious that this might very well mean the end of an airline.

Thus, from this angle the object of an airline's equipment policy is to create and maintain a fleet of aircraft which will meet the mandatory requirement for an acceptable level of safety. If this result is not achieved, *economy rather than safety will be impaired.*

Against this background it might be of interest to see what can be done to ensure the necessary equipment safety.

Fleet composition

Airlines operating many different types of aircraft are faced with maintenance and operational problems which, if not given proper attention, tend to reduce the overall safety of flying.

The greater the variety of aircraft in use, the greater is the number of components and accessories to be handled in the shops. There is an obvious risk of confusing similar parts from different aircraft and even more of mixing up settings and measurements for components which differ only in this respect for different types of aircraft.

A Douglas DC-6 of SAS undergoing overhaul at the company's hangar at Kastrup Airport, Copenhagen. Similar facilities are available at Bromma Airport, Stockholm, and at Fornebu Airport, Oslo.

Conditions are aggravated if aircraft from different countries of origin are operated from the same base. Here inevitable variations in standard parts specifications and raw materials will result in a simultaneous appearance of non-interchangeable parts. In order to preclude dangerous confusions, very rigid shop practices and inspection procedures have to be established, which would not have been necessary with fewer types of aircraft in the fleet.

Too many types in an airline's fleet will also cause personnel problems. A pilot cannot safely switch from one type to another on a day-to-day basis. Consequently, flexibility in the utilization of aircrews is rapidly reduced with an increasing number of types in the fleet. Similarly, a greater number of specialist ground personnel is required as the diversity of aircraft types increases, if the greater risk of human error is not to show up in terms of a declining safety level.

Standardizing on the fewest possible types of aircraft in the fleet, preferably built to the same industrial standards, not only improves safety and reduces costs but also permits a streamlining of the airline's entire organization. Thus—and this is not the only proof of this rule—an equipment policy promoting safety will generally also be the basis of a sound economical structure of an airline.

As important as the reduction of the number of types in the fleet to the barest minimum compatible with the airline's route system and types of operation is the *provision of an adequate number of aircraft for a given traffic job.* The fewer the aircraft, the higher the utilization and the greater the stress on all resources. Beyond a certain limit, which varies with individual circumstances, this will definitely lead to a reduced safety level. Lack of traffic reserves, more exacting scheduled connections, reduced shop time for maintenance and overhaul—all tend to make the organization work closer to the borderline of safety. The cry for high utilization has become a slogan that conceals from many airline executives the fact that excessive utilization not only endangers safety because of the resulting pressure on the organization, but also costs money in terms of higher salaries, greater staff and more improvising; furthermore—and this might be worse—it greatly reduces the airline's flexibility of action and capacity to handle new and unexpected traffic situations.

A cold-blooded analysis will show that the additional cost of maintaining one or two extra aircraft in a fleet may very easily be compensated for by more passengers being attracted to an improved service which, in turn, is made possible by the additional aircraft.

Choice of equipment

The only way to obtain complete assurance that new equipment is well "debugged" and will not give costly surprises due to weak safety features, is to pick aircraft types with years of large-scale operational experience.

Obviously this cannot always be done, or progress would be halted. In many cases individual requirements over a specific route system are not satisfactorily met by existing types. In other cases competition calls for the introduction of more advanced types. Finally, the rapid advancement of aircraft engineering gives an economical superiority to the latest developments which no airline in the long run can afford to disregard.

If new equipment still on the drawing boards or in its initial stages of development is thus to be adopted, what are the considerations which will determine an airline's choice ?

Perhaps the major single factor is confidence in the manufacturer. This does not mean confidence only that the manufacturer will obtain his guaranteed performance standards, but equally that he will be able to create a product with sufficient functional reliability, serviceability and durability. It also means confidence that he will back up his product during its coming operational life. No intricate contract clauses can replace this faith or make up for a manufacturer's inability to meet it.

Of course, the initial choice of equipment also involves analysis of its suitability for its intended purpose, its earning power and its competitive qualities.

The overall level of equipment safety is greatly influenced by the proper application on the part of the manufacturer of the airline's previous operational and technical experience. *The airline's role is to state the problems, the manufacturer's to find the design solutions.*

Selection of proper types of engine, propeller, accessories, instruments and communications equipment also has great bearing on equipment safety. The airline itself usually takes a large share of the responsibility for this. Choice of such equipment will be based on previous experience and on an evaluation of new products and available improvements.

One major consideration in connection with the specification of these integral parts of the aircraft is standardization. The degree and thoroughness of standardization of the instrument panel, positioning and functioning of controls, etc., evidently can greatly reduce potential hazards of flight crew error under critical conditions.

Preparation of a new type for commercial operation

During the earlier stages of developing a new aircraft, laboratory component testing and system testing are performed to a large degree. Much is achieved in this way in terms of developing safety and functional reliability long before the prototype is ready.

When the prototype takes to the air, the most important test and trial period starts. First the basic airworthiness of the type has to be established and performance and other data gathered to form a basis for future operation of the type.

The overall functional reliability and serviceability is established during so-called "accelerated service tests." These are usually, at least partly, carried out by the manufacturer. It is common, however, that the airline at some stage takes over the prototype on a loan basis and makes its own service tests and trial operations simulating regular airline service.

During this period preliminary maintenance and operational practices are developed in close cooperation with the manufacturer, and preliminary overhaul and check periods are worked out for the aircraft and its components. Suitable take-off, climb and approach procedures as well as detailed cockpit drill are developed, and the new type is given its first real shake-down under conditions simulating rigid airline schedules. This trial period might cover several hundred flying hours.

The certification tests and the trial operations result in a great deal of modification, much of it dictated by safety requirements. They have to be worked into the design and will appear as improvements to the production aircraft.

Initiation of commercial operation

As the detailed type specification for the new type aircraft is settled, planning and procurement of spare components and spare parts can start. Selecting the proper quantity of each item requires much experience and a thorough knowledge of shop procedures and operational requirements. Since the value of the complete spare part procurement for a new type may run as high as 50 percent of the aircraft price, it is obviously important from a financial point of view that this work is done with great care. (For additional aircraft of a type already in operation this figure may go down to 25 or even 15 percent.)

Raw materials stock room at SAS' shops at Bromma Airport, Stockholm. Order and carefully developed procedures prevent mistakes.

A view of the interior of the SAS training centre at Bromma, Stockholm. Flight and ground crews are given class-room instruction on a new type of aircraft before it is even delivered.

A generous and well-balanced procurement policy with regard to spare parts pays off in terms of improved safety as well as greater overall operational efficiency. When the first production aircraft approaches the end of the assembly line, a new phase in the airline's re-equipment activities begins. First, a staff of engineering and maintenance specialists start work on the preparation of all required maintenance and overhaul instructions, establishing technical operating procedures and information, and preparing training courses for flight and ground personnel. Closer to the time of delivery these courses are widened, and all personnel concerned are given class-room instructions on the new type.

In connection with delivery of the first aircraft, a nucleus of flight and technical personnel receives the final instructions by the manufacturer and the first aircrews get their flight training. Upon the aircraft's arrival at the home base, practical training of flight and ground personnel takes place. When this practical training is completed, the final preparatory phase of the introduction of a new aircraft type is ended and the type is ready for commercial operation.

Day-to-day safety

The initiation of commercial operation with a new type does by no means represent the end of its development. Sometimes—unfortunately these cases are not uncommon—deficiencies appear after the aircraft has been put into service, in spite of all the extremely careful preparations. This may prove to be very costly to the airline and naturally also to the manufacturer. But safety can never be tampered with, and it is preferable to ground the fleet until remedies have been found, if the character of the deficiency dictates it.

Most of the development work and improvements, however, follow a less dramatic course, but are no less important. There is a constant and close watch by the airline's engineering and operational staff over the technical reliability and integrity of every aircraft in operation. As a result, a constant flow of information and suggestions is maintained between the airline and the manufacturer during the lifetime of an aircraft, and introduction of new improvements aiming at greater reliability and safety never stops. After a decade of operation, accumulated major and minor modifications may run into thousands.

Equipment safety and the authorities

The two parties, the airline and the manufacturer, certainly are aware of their responsibility towards the public—because maintaining public confidence is the only way for them to stay in business. The public itself, however, has its own means of checking that the airline and the manufacturer live up to their required standards. The civil aviation authorities supervise every phase of the development and operation of every commercial aircraft in accordance with a strict and detailed framework of regulations and requirements.

Close cooperation is maintained by the airlines and the manufacturers with the authorities in developing these regulations and requirements. Proposals and comments are constantly exchanged, channeled through national and international bodies such as local CAAs and the ICAO on behalf of the governments, and bodies like the U.S. Aircraft Industries Association, the Society of British Aircraft Constructors, the Air Transport Association of America and the International Air Transport Association on behalf of the manufacturers and the airlines. The airworthiness regulations thus developed are basically aimed at the development of airworthy flying equipment, i.e., aircraft which will be safe under all normal conditions and which can cope with any emergency that could reasonably be expected. For example, the safe functioning of multi-engined aircraft must not be endangered by the complete failure of one engine (in the case of four or more engines it must be possible to bring a flight to a safe landing with two engines stopped), the airframe must be strong enough to withstand any load that could reasonably be anticipated due to gustiness or manoeuvres, any possible fire zone must be equipped with fire detectors and fire extinguishing means, etc.

These governmental rules also cover the operation of aircraft. They limit aircraft gross-weight with regard to prevailing conditions to make each separate stage of every flight safe not only under normal conditions but in emergencies as well. For example, gross-weight has to be reduced to compensate for insufficient runway length, for terrain obstacles which are too high for the aircraft to fly over with one engine out at maximum weight, for high temperatures which reduce the performance of the aircraft, etc.—Operating rules also establish a safe correlation between board equipment, routes and types of operation. They specify minimum safety standards for tankage, crew requirements, etc., which are related more remotely to the equipment safety as such, but which greatly influence the equipment characteristics to be specified in order to satisfy an actual set of operational conditions.

Summary

The first conclusion is that any equipment policy that does not regard safety as one of its primary aims will turn out to be an expensive policy.

Some of the significant characteristics of a sound equipment policy are :

Standardization of the fleet on the fewest possible types of aircraft ;

A procurement policy that is on the generous side both with respect to number of aircraft and spare parts quantities ;

Selection of reliable and well-proven equipment.

If no existing type of aircraft fulfils the established requirements, a new type of aircraft has to be developed by a manufacturer who can be expected to steer his project to a successful result and subsequently to back his product. Close cooperation has to be maintained between the airline and the manufacturer during the development period in establishing detailed type specifications.

Proper planning of the introduction of new aircraft in commercial operation is of primary importance with respect to safety.

Continuous safety of flying is safeguarded through a careful follow-up of every aircraft in operation and through addition of improvements when conditions so require. The manufacturer's interest in maintaining this day-to-day safety is just as important as his responsibility for the original development of the type.

Safety first

Air Traffic Control—Air Traffic Safety

BY A. G. FISCHER, RADIO SWITZERLAND LTD., ZURICH

Geneva-Cointrin airport's radio and MF D/F station (call-sign HEW) is situated on an extension of the landing runway (at its north-east end). It is connected by landline to the transmission aerial (south of the main building) and by telephone to the control tower. It also houses the Geneva area control centre and its teleprinters. MF D/F frames on the roof.

Yesterday

When commercial aviation took its first faltering steps some thirty odd years ago there was one basic requirement for every flight, and that was *good weather !* Rain and low cloud meant either indefinite postponement of the flight . . . or a dare-devil trip along railways, valleys, roads and rivers, at the end of which the pilot wiped the cold sweat from his brow and looked for his name in the paper as a "hero of aviation."

In those days flying was for the man with time. This, of course, was not exactly the way to make money, so by the middle of the 'twenties "instrument" flying was invented. The pilot flew through the clouds and then looked round thoughtfully to see how he could get his blind bat to its destination. Then a new child was born—a ground organization to provide assistance and protection to air traffic by radio—today called "air traffic services" and aeronautical telecommunications. This grew up alongside its big brother air transportation, to the surprise of its parents eventually becoming a veritable giant [1].

The milestones in the development of this organization in Europe are roughly as follows :

DEVELOPMENT OF AIR TRANSPORTATION	DEVELOPMENT OF GROUND ORGANIZATION
1919 : Beginnings of commercial aviation ; good weather flights with ground visibility.	Beginnings of use of radio for communications ; chiefly for transmitting weather reports from airport to airport by Morse W/T. First attempts to provide air-ground radio communication by long-wave R/T.
1925/27 : Beginning of instrument flying through cloud ; navigation no longer entirely by ground landmarks but sometimes also with the aid of radio messages transmitted from the ground.	Build-up of D/F organization as aid to air navigation, in particular by giving position fixes. First assistance for "descent through cloud" for approach to airport with relatively high cloud base.
1928/29 : Extension of instrument flying, now become a little more popular. R/T abandoned in favour of Morse W/T as means of communication with the ground. Special radio operator occasionally carried.	Introduction of telecommunications regulations and Q code. Introduction of aviation weather service with trained meteorologists.
1930/32 : Beginning of year-round operation of certain routes. Radio operator now general as crew member. Introduction of "ZZ" system of bad weather approach (blind approach to airport by means of radio bearings).	Expansion of ground stations with more efficient D/F equipment in the medium waveband. Ground stations accepted responsibility for correct navigation in ZZ blind approach. Opening of international teleprinter connections for transmission of weather reports and operational messages.
1933/34 : Instrument flying has become as natural as year-round flying. More accurate blind approach procedures on a radio-electric beam. Reduction in weather minima for landing.	Introduction of first Lorenz VHF landing beacons at a few airports. (Origin of SBA system still in use today.) Organization of central stations for collecting and disseminating notices to airmen in Europe.
1935 : Introduction of American high-speed aircraft, e.g. the Douglas DC-2.	Organization of air traffic control on a pan-European basis. Conversion to short waves in the aeronautical fixed telecommunications service. Considerable expansion of meteorological service.
1936/39 : Consolidation of past achievements. Beginning of radio navigation by means of airborne instruments.	D/F organization assisted by construction of a network of non-directional radio beacons (NDB). Introduction of pulse D/F equipment to eliminate night error.

[1] For details of the aeronautical radionavigation systems described below, cf. pp. 218-221.—Editors.

In brief the stage of development reached in safeguarding air navigation in Europe up to the outbreak of war in 1939 can be described as follows :

Thanks to the increased density and speed of air transportation, the ground organization provided to safeguard flight had reached a turning point. Its original main task, that of assisting navigation by transmitting D/F bearings, had lost much of its importance because the D/F stations had become congested. Aircraft were navigating more and more with the aid of airborne equipment and a network of non-directional beacons.—A new task was coming to the fore, that of bringing order into air traffic, of regulating the flow of traffic, in short of air traffic *control.*

During World War II with its enormous bomber squadrons, its all-weather flying and mass landings in bad weather and at night, all branches of aeronautical engineering were promoted regardless of cost. Then came the tremendous upward swing in commercial aviation. The International Civil Aviation Organization set out to produce a useful mosaic for civil aviation from the scattered fragments of equipment, organization and systems left over from the war, and in the famous *Report S. C. 31* of the Radio Technical Commission for Aeronautics 85 American experts tried to disentangle the threads and make a pattern which could be followed by aircraft and radio industry, airlines and governments in their planning, designs and investments.

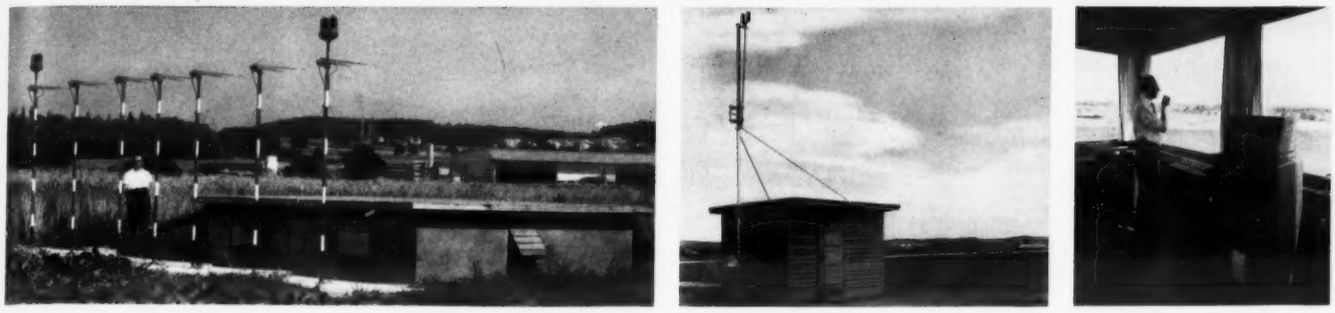
Today

The ground organization for the protection of aviation, whose costs, with few exceptions, are borne, by the way, by the individual countries, has become a very complex affair. It is by no means easy to give a comprehensive view of the whole, with all its problems and ramifications, within a small space.

With a little effort the domain of the air traffic services can be divided into three sections : navigation aids, air traffic control, communications. Some "effort" is definitely required, however, since each section is so closely connected with the two others, and description of each without reference to the others would give an incomplete picture.

The qualities required of *navigation aids* vary considerably according to whether they are to be used over large uninhabited areas such as oceans and deserts, over medium stretches of inhabited territory, or over short distances in the immediate neighbourhood of airports.

In the first case accuracy of navigation, for example, is not very important. The problem is relatively simple, i.e., to obtain adequate



ILS equipment at Zurich-Kloten airport (ITT-Standard). Left : transmitter hut and aerial array of localizer ; centre : aerial array and equipment hut for glide path transmitter ; right : remote control unit in control tower. Operator talking with approaching aircraft via the localizer.

range in the navigation aid and low susceptibility to atmospheric disturbances. The most widely-used long-range aids today are the medium frequency Consol systems with ranges up to 1600 miles, and the hyperbolic system of LORAN stations. However, the scope of this article does not permit of further space being given to long-distance navigation aids.

The problem of *radio aid for medium distance navigation* cannot be judged solely from the point of view of course plotting. Here the requirements of *air traffic control* also begin to play a part.

For navigation purposes alone it could be sufficient, for example, to fix a position every 15 minutes, which should be accurate to within ±6 miles in the direction of flight and ±3 miles to either side. This requirement can be regarded as having been met in general in Europe and in the United States, though a variety of methods is used, many of them in fact giving greater accuracy.

In the *European and Mediterranean region* the considerable number of 500 non-directional beacons (NDB) enables any commercial aircraft to fly wherever it will over the continent merely with the aid of its radio compass, within the above-mentioned accuracy limits. The NDB network is also supplemented, in the areas where traffic is densest, by low and medium frequency radio ranges (RNG) brought to Europe by the Americans (about 60 in all), and finally a large number of ground D/F stations are available to crews on demand, namely about 200 medium frequency and 280 very high frequency stations, the latter being unaffected by atmospheric disturbances.

In the *United States,* where compulsory airways have been insisted on from the first, medium distance navigation is based exclusively on directional beacons, namely low frequency radio ranges, VHF visual aural radio ranges (VAR) and VHF Omni-directional ranges (or omniranges for short = VOR).

From the point of view of *air traffic control,* however, navigational accuracy, particularly in Europe, is no longer adequate, thanks to present-day density of traffic and speeds of flight. Why is this ?

ICAO has given air traffic control two main tasks : firstly to prevent collisions between aircraft on instrument flights, i.e., to keep all aircraft flying blind in the same area separate ; and secondly to see that traffic is kept flowing in the smoothest possible way. The control centres must therefore be kept as closely informed as possible of the positions of all aircraft. An effort is made to fill this requirement by giving each control centre—before the aircraft takes off—its programme of flight, the so-called flight plan. This shows, for example, the exact route to be followed, with estimated times and the altitudes to be observed. These forecasts are supplemented during the flight by crews sending through to the control centres by VHF R/T their position, as determined by themselves, and their estimated time of arrival over the next reporting point.

With the aid of this information the control centre can picture the traffic situation in its area. It then either *approves* the proposed flight plan, or instructs the aircraft to fly at *a different height,* follow a *different route* or *wait* by making a circuit where it is. These are in rough the means by which air traffic control ensures that two aircraft flying one behind the other at the same height do not collide and that two aircraft can pass one another without damage. (As can be seen even from this very rough picture of conditions, *communications* are of great importance in air traffic control, not only communications with aircraft, but also communications with neighbouring centres and with airports of departure and destination.)

The control centre must, however, make allowances in its calculations for a *degree of uncertainty,* which becomes greater the fewer position reports are available and the less reliable are the crews' time estimates. In other words, the less accurate the navigation methods are, the greater must be the separation between individual aircraft in instrument flight. This of course reduces the number of aircraft which can fly on the same course and at the same height within a given period of time. There are also a number of far more complicated cases. If the amount of traffic exceeds these limits, either unwelcome and costly delays will be inevitable, or navigation aids must be improved.

It is tempting to think that this reasoning is exaggerated. The air space seems to be so big that it should really not be too difficult to guide quite a lot of aircraft past each other vertically and laterally. This, however, would be to overlook the bottle-neck in air traffic, *blind approach to the airport, and landing.* Aircraft can only land one by one on an airport's instrument runway, and with today's equipment it is almost impossible to reduce the interval between approaches to less than three

According to ICAO recommendations international airports should have not only ILS but also the GCA radar "Talk-Down" system. Screens for surveillance radar element (left) and precision approach radar (right).

minutes, even at the best-equipped airports ; in fact the interval is very often five minutes or longer.

Air traffic in the control zone of a major airport will present roughly the following picture : Aircraft arrive from all directions at times determined by their time-tables, or frequently by wind and weather. Sometimes a whole collection arrives together. The regional or airways control then instructs the first aircraft to fly in at the lowest altitude (fixed in part according to topographical conditions), the second at the second lowest altitude and so on. This manoeuvre, however, can only succeed if the times of arrival estimated by the aircraft crews are correct. In general therefore the flow of traffic, organized as efficiently as possible, pours into a *holding pattern* marked out by radio beacons or vertical transmitting radio markers, in which the aircraft are separated by a minimum vertical distance of 1000 ft. as instructed by a special "approach control" service. The lowest aircraft in each case moves to the approach lane and begins its final approach for landing.

The particular navigation aids required for instrument approach must be very accurate since the aircraft gets closer and closer to the invisible ground obstructions as it approaches the airport and must finally be able to land at the beginning of a runway not more than 50 to 90 yards wide. The most accurate systems today are *ILS* (in which the pilot can follow the line of intersection of two radioelectric beam planes) and the *Talk-Down system of GCA radar* (in which the pilot is given R/T instructions for course to fly and correct rate of descent calculated from radar observations). That the standard equipment of an airport today includes an *approach lighting system* with very powerful directional lights, without which the last part of the approach and the actual landing in bad visibility would be impossible, need scarcely be mentioned.

Altogether then it is not difficult to see that both navigation and control in the airport control zone are delicate problems. To make sure that aircraft can land at an average interval of 3 to 5 minutes, many requirements must be met. The estimated times of arrival in the control zone must be accurate ; the topography of the area flown over and the needs of safe separation of crossing traffic must permit of the aircraft being stacked in the holding pattern in the order of their arrival ; each individual pilot must be able so to arrange his course from holding pattern to axis of descent that he can begin his approach within a few seconds of receiving the word from control ; and finally there should not be any very great differences in airspeed on the approach. The first three conditions at any rate can be considerably helped by improving navigation methods.

Further delays and interruptions in the smooth flow of landings may also arise from the fact that outgoing aircraft frequently have to use the same radio beacons and other navigation aids as incoming aircraft. Since outgoing and incoming aircraft must always pass each other somewhere in the vertical plane relatively near the airport, this still further increases the air traffic control's difficulties.

The passenger who has spent several hours being carried comfortably from one continent to another certainly does not appreciate being thrown around in his seat for a quarter of an hour at the end of his trip in a wildly circling aircraft in the midst of a zone of turbulence. The crew too will willingly sacrifice such luxuries, quite apart from the airline, who can make better use of their expensive fuel. If waiting in the control zone is unpleasant today, it will be *impossible* tomorrow. For we are on the threshold of air traffic with jet-powered aircraft whose high fuel consumption—particularly at low altitudes—imperatively demands undisturbed approach to the airport.

The task now is to *improve navigation aids so as to achieve smooth running of air traffic*. Good results are promised by a number of technical and organizational measures, some of which are almost ready to be put into practice. An attempt is made to describe these below.

Tomorrow

The need is for a navigation system which enables an aircraft crew to determine its position immediately at any point on the flight and to follow any desired course without making too many calculations. The airborne equipment must be simple to operate and stable ; faulty readings must immediately be recognizable as such.

In the United States the decision has already been made. This decision to introduce *VHF omni-ranges* will not have been too difficult, since it meant no more than a technical perfecting—admittedly a long step—of the trusted old directional beacons on airways. In Europe, however, the American system would necessitate greater changes, and it is not just accidental that VOR should have a competitor in the British Decca system.

The American VOR system enables a pilot to select any desired course and to fly to or from a radio aid by watching a simple pointer instrument. A *Distance Measuring Equipment* (DME), which works on the pulse principle, shows the distance from the radio aid. By using an electronic computor it is even possible to fly past a VOR station on a fixed course with very little effort from the crew. This system is undoubtedly very attractive, since it seems to fill all requirements. Any desired course can be set and maintained with ease within the range of a VOR station, and thanks to the DME, distance to the VOR station and hence the position of the aircraft are known at all times. Opponents of VOR, however, maintain that its angular accuracy is insufficient ($\pm 5°$ is mentioned, instead of double this accuracy as claimed), the distance measuring equipment is too expensive, too heavy and moreover not yet fully developed. Finally, they say, the whole system is too costly, since because of the relatively short range of a station (VOR works in in the VHF band of 112-118 mcs/s) a large number of stations is required to cover an area.

The British Decca system works on low frequencies (80-200 kc/s). so that the range of a transmitter chain is 200-300 miles. Accuracy of navigation with the aid of the Decca hyperbolic system is astounding. However, the presentation of navigational data in the cockpit is undoubtedly less simple than in the VOR system ; with the aid of an automatic equipment (Automatic Flight Log) the route covered is traced on a simplified map. Decca's adversaries object that navigating "backwards" is unnatural, the system is too complicated for the crew and the risk of errors through the use of special maps too great (e.g. mixing up the maps).

As already stated, the United States have decided in favour of VOR/DME, and there are already some 270 stations in operation there and another 150 under construction. So far Europe has managed to produce only about 20 VOR stations, some of them under construction and some

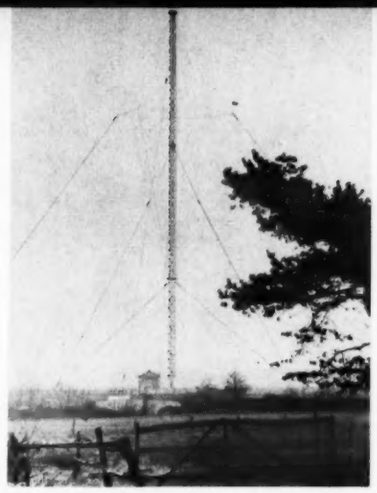
in experimental operation. On the other hand Decca chains already cover large parts of northern Europe, since this system of navigation is also used by shipping.

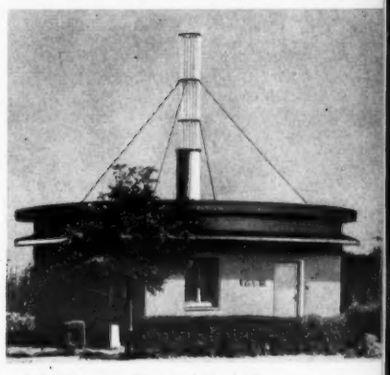
A large proportion of airlines and pilots' associations appear to prefer VOR/DME, and there are many indications (including the fact that it has been recommended as ICAO standard) that VOR/DME will become more widespread in Europe too. For air traffic control purposes finally, both systems are suitable, since both enable crews to give the control centres considerably more accurate and more frequent position reports and also more accurate estimated times of arrival. Full advantage of these important factors can, however, only be taken—and this fact is becoming more and more widely acknowledged—when the *airways system* with its frequent compulsory reporting points is also introduced in Europe. Many countries have already done this, but there is still no *general European solution*. Let us hope that it will be possible to create a European organization of airways controls which will really answer aviation's needs, even if political boundaries have to be ignored.

Here a brief word on *communications* is indicated. It is obvious that the faster air traffic becomes, the better ground communications must be. Along an airway direct telephone and teleprinter connections between one control centre and the next are indispensable, and the system of W/T communications still sometimes found between departure and destination airports is unlikely to be retained very much longer. However, it will doubtless be some considerable time before operational messages from aircraft to their home airports over long distances too will be passed solely via ground communications.

In the question of air-ground communications, efforts at rationalization in the form of extensive use of VHF for navigation and communications purposes are unmistakable. However, an imaginary glance at the future shows clearly that air traffic control's increasing need for spoken communications with the aircraft will some day lead to congestion of transmission channels such as can no longer be cured by decentralization of control. It will therefore scarcely be wrong to assume that even R/T communications, however practical and simple they appear today, will some day have to be replaced by a better system (projects for which already exist).

To return to navigation aids, however ! Improvement in en route navigation aids have only an indirect effect in the *airport control zone* in relation to smoother handling of air traffic. In the control zone itself too better methods must be introduced, and here the claims of *radar* need to be heard. The further the assistance of the surveillance radar element (SRE) reaches out beyond the control zone, the easier it will be for air traffic control to regulate incoming and outgoing traffic. The particular difficulty encountered in radar control in densely-flown airport control zones is in identifying the radar pips on the control screens.





Left : One of the four 330-ft. self-oscillating masts of the German Decca chain built by Telefunken (100 kc/s). The master station is at Madfeld (Westfalia), and the slave stations each 120 miles apart, at Coburg (Bavaria), Stadtkyll (Eifel) and Zeven (Bremen). Wire cage increases the aerial power.
Right : The VHF omni-range (VOR) at Echterdingen airport, Stuttgart (C. Lorenz AG).

This problem may perhaps be solved by equipping aircraft with transponders, which cause the radar echo for each aircraft to take on a different form.

In any case it is now clear that SRE, which was originally designed merely as a feeder for the precision approach radar (PAR), has long earned its own right to existence, since the regulation of aircraft movements in busy control zones, the guidance of incoming and outgoing aircraft past each other, the observance of safety separation and insurance of the maximum possible utilization of take-off and landing runways, can only be carried out with the aid of SRE.

The problem of completely *blind landings* when visibility is zero has still not been solved, and it even seems premature to forecast what type of system will replace the present standard—*ILS + PAR + high intensity approach and runway lighting*. In theory there are three possible lines of development : to dissipate the fog, to make the runway visible through the fog, or to render blind approach and blind landing fully automatic (or a combination of these methods). Both science and industry are working on all three lines with varying success.

*

If finally we ask ourselves what new *control aids* must be made available, we realize soon enough that with air traffic becoming denser and aircraft flying faster and higher, the control station must have equipment which will give it, above all, a constant picture of the traffic situation. We may also shortly be reaching the point where only a calculating machine, working with data supplied by radar, can work out a rational control of aircraft movements. This may well be the first step towards air traffic control's becoming automatic, though full realization of this plan is doubtless some way off in the future.

*
* *

Safety First

How to Make Yourself Understood...

"Q-Code," "ILA-LAI" and a Rhyming Alphabet

Technical jargons? Latin, the technical jargon of the Middle Ages was a closed book to the layman, but was understood at least by the educated of every tongue. Present-day technical jargons, however, are familiar only to members of specialized trades or professions in a single country... if "familiar" is the right word.

In international air transport it was at one time easy to make oneself understood, when radio, as mute as a codfish, was confined to the dots and dashes of the morse code. On medium and long waves conversation—or rather radio correspondence—ran very smoothly. Radio operators on the ground and in the air used the so-called "*Q-code*," in which all questions and answers can be expressed as groups of three letters, beginning with "Q." The Q code admittedly is somewhat "wordy"... from QAB to QUX there are today no fewer than 485 groups of letters. If he is in any doubt, however, the radio operator has only to open the neat Q code manual in front of him (with practical thumb index for the second letters of the group) and he immediately knows where he is.

The introduction of VHF communications in air traffic upset all this. Thanks to R/T, radio operators of all lands can now converse with one another orally, with the result that no-one understands his fellows... as sometimes happens elsewhere in oral conversations. Apart from dialect expressions (which leave the other man cold, however telling they may be), the French operator, for example, gets the wind up when, instead of his school English, he hears pure West Coast American... or vice versa when the American is confronted with Marseilles French.

In brief, things had got in a mess. Fortunately, there is an organization whose job it is,

so to speak, to apply a spot of oil to any creaking parts in the structure of international air transport, namely, the International Civil Aviation Organization (whose double name—ICAO in English and OACI in French and Spanish—alone shows how difficult it is to find an international language).

The Communications Division of ICAO therefore started, at its fourth meeting in Montreal a year ago, to prepare a standard "*International Language for Aviation*," which (in the interests of standardization ?) is to be known as ILA in English, and LAI (Langue Aéronautique Internationale) in French and Spanish.

Even Russia was intrigued. Although she did not occupy the place on ICAO's council left vacant for her, she did send four—and later seven—observers to the committee meetings to see how several languages could be made into one.

In rough this is to be done as follows: "aviation esperanto" is to be based on *English, which is in current use in aviation,* with preference being given to words of Latin origin—for one thing to avoid the tongue-twisting English *th*. In speaking figures, for instance, "three" is pronounced "*tree*" and "thousand" "*tousand*." Words and phrases should be chosen for their suitability for radiotelephony communications, and any words whose pronunciation differs very markedly from one language to another or may give rise to misunderstandings should be avoided. Messages should be precise, simple, unambiguous, short, though clarity may not be sacrificed to brevity. Vocabulary must include the commonest groups from the R/T Q code and other code words (OVER, OUT, ROGER, WILCO, etc.). And, most important, affirmative and negative messages must be clearly distinguishable—a commendable practice in all walks of life.

So much for ILA. Since it will obviously be some time before it is generally introduced, and radio-telephony will go on being used in the meantime, the Communications Division has issued new "*Radiotelephony Procedures*" to enter into force on April 1st, 1952. Figures (meanwhile it has been agreed that metric and maritime measures shall be introduced step by step) are to be pronounced as follows: 0 = zero, 1 = wun, 2 = too, 3 = tree, etc.

To simplify the spelling out of proper names, service abbreviations and difficult words, an international word spelling alphabet has been provided, on the same lines as the one used in normal telephone communications.

The code words in this alphabet have undoubtedly been skilfully chosen, since they exist in almost all living languages. Nevertheless, it means another code to be learned! Interavia has taken pity on harassed pilots and radio operators and has commissioned a number of "notorious aviation poets" to write rhymes on the 26 code words in the ICAO alphabet. They set to work bravely... but the editors cannot accept any responsibility for their flights of fancy.

A = ALPHA	A's for **A**lpha, I'll not forget, When once I've learned this alphabet.	Aleph ou bien Alpha, début de l'écriture. Début aussi d'Avion, début de l'Aventure...	Si es Alfa lo que percibes, apunta un A donde escribes.	mit geschwungnem Schweife erinnert an die **A**nflugschleife.
B = BRAVO	**B**ravo ! that's wizard, bang-up, swell. As word for **B** it rings the bell.	Quand perdu dans la Brume on entend la radio on voudrait lui dire Bis. On lui criera: Bravo!	**B**ravo significa BE. Lo digo y lo mantendré.	ruft vom Turm der Mann, nach blinder Landung auf der **B**ahn.
C = COCA	Coca-cola, a drink that's plain, But **C** can also spell champagne.	Coca-cola, à bord, n'est-ce pas insensé? Car le Cognac, aussi, commençait par un C !	En la inicial de la Coca, está la Ce que le toca.	Cola schmeckt dem Völkchen, am Boden, wie im Cirrus-Wölkchen.
D = DELTA	And now comes **D**, the delta-wing, The designer tells me, is a daring thing.	Le triangle à l'envers, cher à l'épicurien, n'est plus, pour l'ingénieur, que l'avion de Demain.	Letra griega y ala extraña que se llama DE en España.	« Dreieck-Flügelform » wird demnächst Düsenjägernorm.

	E = ECHO	Here I come, so bright and breezy, With **E** for **E**cho, sure that's **e**asy.	C'est une nymphe en pleurs, qui se plaint de Narcisse. N'as-tu pas, dans chaque port, pilote, une Eurydice ?	La E con que empieza el Eco queda en medio del chalEco.	Ist der Hafen nah, heisst unser Echo : **E**rika.
	F = FOXTROT	And **F** for **F**oxtrot ? What delight ! It's my favourite pastime after **f**light.	Mais quand tu arriveras, ce soir, à Santiago, Ne choisiras-tu pas, radio, le Fandango ?	Se inicia el Foxtrot con Efe como acaba el mequetrefe.	Damenwahl — und Sieger bleibt stets die Uniform der **F**lieger.
	G = GOLF	But **G** for **G**olf, that's not so gay, I'll wait for that till I'm old and grey.	Trenet eut écrit Golfe, où va danser la mer... On a choisi des trous, des petits trous pas chers !	¿ Oyes Golf ? Escribe, Ge, sin preguntarte por qué.	-Spiel nach der Väter Weise, ein Sport für respektable **G**reise.
	H = HOTEL	**H** for **H**otel, from New York to Rome, Wherever I'm landed, is a home from **h**ome.	Aucune autorité ne s'est donc avisée Que dans le mot Hôtel l'H n'est pas aspirée ?	En Hotel no suena la Hache, pero retumba en Larache.	dort geht würdevoll Sir William Hildred durch die **H**all.
	I = INDIA	'Twas I for item on the older list, Now on **I** for **I**ndia I must **i**nsist.	La nuit de l'Inde : au loin un minaret jauni, la lune dans le ciel, comme un point sur un I.	Hay en la India alfaqui les con puntos sobre las les.	will uns Frieden geben mit Spinnrad, Sanftmut, Innenleben.
	J = JULIETT	For **J** for **J**uliett we used to weep, But the modern **J**uliett rides a **j**eep.	Il manquait dans ces noms celui d'une héroïne. Jezabel est trop vieille, trop jeune était Jocelyne.	Si Julieta no fué inglesa, la Jota es aragonesa.	geh' ich nicht fehl, schwört Romeo auf dies **J**uwel.
	K = KILO	**K**ilo as the word for **K** Tells me to check my weight's O.**K**.	Un mot vraiment français commençant par un K bien que ce fut du grec qu'on nous le fabri**K**a.	Reluce la K en el Kilo como el sol brilla en el Nilo.	Zentner, Tonnen gar, doch nie ein Kilo **K**aviar.
	L = LIMA	Of all the towns for which **L** can stand It's **L**ima where I love to **l**and.	Certes, il opportait de trouver le Pérou. Mais Lisbonne et Lausanne avaient un L, itou !	Ele nos anuncia Lima : buena gente ; mejor clima.	Selbst am Fuss der Anden gehört der Lippenstift zum **L**anden.
	M = METRO	But when in Paris I want a train, I say **M** for **M**etro with might and **m**ain.	Pour bien rendre le M il faut un Mot qui sonne. Il n'en est vraiment qu'un : c'est le Mot de Cambronne.	Del Metro, en toda escritura, es Eme la abreviatura.	Wer ist heut bei Kasse ? Sie ist der Cadillac der **M**asse.
	N = NECTAR	**N**'s for **N**ectar, of that I'm sure, Though nectarine would be much **n**ewer.	Si ce qu'on chante est vrai, c'est le régal des Dieux. N'ont-ils pas le champagne, hélas ! les pauvres vieux !	La Ene que en el Néctar vemos tiene sus más y sus menos.	bringt die Stewardess : Bier, Wein, Likör und... **N**ahrhaftes.
	O = OSCAR	I see they've made a film of Tosca. Ah, that reminds me, **O**'s for **O**scar.	Un film sur l'aviation, si la Gloire ne boude Recevra bien un jour ce grand prix d'(H) Ollywood.	¡Oh! ¡Cómo se siente ufano con el Oscar en su mano !	-Preis, dich muss ich loben, du ziehst die Filmkunst steil nach **o**ben.
	P = PAPA	Now what comes next ? I'll look again. It's **P** for **P**apa. Yes that's **p**lain.	Pilote, Pense un Peu au Possible accident : un bon Petit Papa Plus qu'un autre est Prudent.	Nos explicaba el Papá la turbina de Pe a pá.	kann mit Mama reisen im Coach-Verkehr zu halben **P**reisen.
	Q = QUEBEC	My old ideas I now must wreck, Not Q for queen, but **Q** **Q**uebec.	Pour désigner le Q on a choisi Québec. On n'a pas tenu compte Qu'il est bien loin du bec.	Suena la QU de Quebec como la « c » de biftec.	Hier wie anderswo hört man nur ungern « **Q** G O ».
	R = ROMEO	Poor Roger's out, he'll be quite frantic, Now **R**'s for **R**omeo, the guy **r**omantic.	Pour monter au balcon, où ses amours l'espèrent, Roméo désormais, prendra l'hélicoptère.	Hasta que el amor lo entierre, Romeo seguirá Erre que Erre.	so sollt man meinen, ist mit Juliett schon längst im **r**einen.
	S = SIERRA	**S** for **S**ierra, a mountain chain, I learned in school there's one in **S**pain.	Aux Serpents de Racine qui Sifflent sur ces têtes On préféra Sierra... On pouvait dire Sucette !	Contempla Sierra Nevada, Ese que vuela a Granada.	hat stets Wind genug für Stratosphären-**S**egelflug.
	T = TANGO	And Spain's the place too, for fandango, But I must think of **T** for **T**ango.	Navigateur, ici nous retrouvons encore Uranie ? Oh non pas : l'aimable Terpsichore.	El Tango que Te fascina lo debes a la Argentina.	muss durch ...zig Instanzen der Reisende mit seinem Passe tanzen.
	U = UNION	**U** for **U**nion. I'm so confused. It's U for uncle I've always **u**sed.	Serait-ce démontrer trop de misanthropie De dire que l'Union n'est que simple Utopie ?	Que Unión equivale a U, no olvidarlo debes tú.	Völker Hand in Hand. Meist aber siegt der **U**nverstand.
	V = VICTOR	Let no one say that this has licked her, So here we go with **V** for **V**ictor.	Bouclant le kilomètre, autrefois à Issy, Farman dit à Voisin : Veni, Vedi, Vici.	En Victor, Ve lo contrario del deseo de un adversario.	Wenn du auch gewinnst, ist es nicht immer dein **V**erdienst.
	W = WHISKY	**W** for **W**hisky can make me sing, And almost want to walk the **w**ing.	Bien mieux vaut évoquer un bon vieux « drink » à l'eau Que l'affreux souvenir du morne Waterloo.	Doble ve quien bebe doble el Whisky, bebida noble.	schmeckt an Bord weit besser als Vichy oder andre **W**ässer.
	X = EXTRA	For **X** I must ask for **E**xtra time, I've thought and thought, But can't find a rhyme.	Prononcer « Ex » pour « Ixe » ! Ne soyons pas critique : peu importe l'accent, pourvu que l'on s'EXplique.	Equis Extra y reaccionaria seria cosa extraordinaria.	-laut tönt's aus der Strippe, spricht in das Telephon **X**anthippe.
	Y = YANKEE	This time there'll be no hanky-panky, What can it be but **Y** for **Y**ankee ?	Si d'aventure la Tour, vraiment, répond trop sec, c'est qu'on est dans le Sud. Il vaut mieux dire I grec !	Yanqui : Y de Salamina y al final otra latina.	fliegen muss vom Hudson bis zum **Y**alu-Fluss.
	Z = ZULU'S	With **Z** for **Z**ulu to close the deal; I've got to the end with a little **z**eal.	On avait Zanzibar, Zazou ou Zig-Zaguer. Et un excès de Zèle pouvait faire... Zézayer !	La Zeda vale Zulú que rima con Tombuctú.	Hautfarb schwarz sein soll, die schwärz're Seele hat der **Z**oll.

Strictly copyright : Interavia 1952.

Safety first

The Maze of Accident Statistics

BY H. SCHREIBER, WINTERTHUR

Airline advertising everywhere is busy hammering into passengers' heads that flying today is just as safe as any other form of transport.

Does this publicity reach its mark ? Is flying safe ? Safety in air transport has, of course, increased tremendously during recent years *, and in practice we can almost begin to talk about complete safety. The trouble begins, however, when comparisons are made between different modes of transport which have nothing in common.

One technical journal maintained for example, that air travel, measured by the number of passenger-miles performed, is today three times safer than travelling by private car. As if the number of passenger-miles performed by private cars could ever be accurately calculated and recorded in any country in the world, as is done for commercial aircraft. Another source assures the shipper that he will only lose his air freight consignment after 20 million ton-miles. The figure wizards on the other side produce accident curves to prove that the railway passenger travels five hundred times more safely than the air traveller.

The thoughtful man will find it difficult to see what connection there is between an air traveller on a trans-Atlantic service and the passenger on a little local railway. True, both get on and off . . . But what happens during the trip of a trans-Atlantic aircraft and one on the local railway simply cannot be brought to a common denominator.

Disraeli once told the House of Commons that there were three kinds of lies : lies, damn lies and statistics. We maintain that statistics can involve any kind of perjury ! And they are used to prove everything, including safety in air travel.

As is well-known the statistician can hope for satisfactory results from his calculations only if he has the "law of big numbers" on his side. Now, it is only a few years since world air transport has taken on such proportions that the levelling effect of figures running into millions can be felt. In statistics, too, it is essential that only similar things should be compared. Reliable clues to the development of air transport safety can only be obtained if statistics are limited to clearly defined operating groups, such as a definite, densely-flown route or an aircraft type in general use. Statisticians can, of course, ascertain how flight safety developed between 1946 and 1950 in the United States on the one hand and in Europe for example on the other. But a comparison of these two sets of data could give only an incomplete picture of the "reliability" of air travel over the two continents. However, if figures are restricted to the accidents occuring in Atlantic traffic, useful information on the "safety share" of European and American airlines can be obtained, since both groups use roughly the same flying equipment under roughly the same conditions. Understandably the tendency for the risk to improve, deteriorate or remain constant cannot be judged until several years have passed.

What does the traveller want to learn from statistics ? Whether he can travel more safely by air or by surface transport. Here, however, he must realize from the start that the conquest of the third dimension (and according to Professor Einstein the fourth too, gain in time through increased speed) must necessarily involve increased risk. Our forefathers, when they went over from walking to travelling by horse and cart, and later from stage coach to railway, knew without the aid of statistics that they were running a greater risk. This risk they consciously accepted. Today complicated calculations are made to find out how many passengers must be carried in ocean liner or Atlantic aircraft before things go askew. It might even be found through persistent reading of the statistics that the passenger will die of old age before the accident happens. What would this prove ?

The results of statistics for different means of transport could only be satisfactorily compared with each other if a suitable criterion were found for the value of speed. Such a criterion has not been discovered so far.

Every means of transport arrives during its history at a specific degree of safety which (as today for the railway) remains roughly constant over several years and only changes when operating conditions change. We might speak of a "saturation point" of safety, the *optimum condition* being obtained when the *probable total travelling time up to the expected accident coincides with the average "expectation of life" of the passenger.*

Let us try to work out a rough calculation of the air travel risk on this basis. Let us assume one fatal accident per hundred million passenger-kilometres (a figure which has already been exceeded by a good many airlines), taking a moderate cruising speed of 285 kilometres per hour. This gives, for *the "critical passenger,"* 350,000 hours of flight or in round figures 14,600 days and nights, or a *full 40 years of unbroken flight . . . before a fatal accident occurs.*

The death tables of the insurance companies show, surprisingly enough, that before the turn of the century a new-born infant had a life expectancy of 40 years, as much as a person of 32 today, who is regarded by the insurance companies as likely to reach the average age of 72. It will therefore be seen that—statistically—flying safety is beginning to approach the general expectation of life. That it is also improving from year to year is shown by a table prepared by the Air Transport Association of America ("Facts & Figures") for 1951.

The future will bring new problems. Helicopters and jet propulsion will lead to further changes in estimates of flying risks. How the statistician will then tackle his job remains to be seen.

* Cf. table below.

COMPARATIVE TRANSPORTATION SAFETY RECORD

	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951
American domestic scheduled air transport, fatalities	55	22	48	76	75	199	83	93	96	x
Rate *	3.66	1.32	2.09	2.14	1.20	3.21	1.3	1.3	1.2	1.4 CAA
American international scheduled air transport, fatalities	0	10	17	17	40	20	20	0	48	x
Rate *	0	3.9	5.3	3.7	3.6	1.1	1.0	0	2.1	1.2 CAA
Bus traffic, fatalities	x	x	x	120	140	140	120	120	x	x
Rate *	0.23	0.22	0.22	0.17	0.19	0.21	0.18	0.20	x	x
American railroad traffic, fatalities	110	262	249	142	116	74	52	32	177	x
Rate *	0.20	0.30	0.26	0.16	0.18	0.16	0.13	0.09	0.56	x
Private cars and taxis, fatalities	x	x	x	12,900	15,400	15,300	15,200	15,300	x	x
Rate *	2.7	2.7	2.9	2.9	2.5	2.3	2.1	2.0	x	x

* Fatalities per 100 million passenger miles
x Not available

Investigation of Accidents

In spite of all precautions, in spite of the strictest standards in the selection and training of flight crews, in the design and operation of flying equipment, accidents cannot be entirely prevented. No domain of human activity ever reaches perfection. Nevertheless, in aviation, every effort is being made to learn from past mistakes and to prevent repetitions. The first requirement here—and not always a simple matter—is to determine just what are the mistakes. This is the job of the accident investigators.

Five decades of technical progress have already substantially reduced the number of accidents (in relation to the hours flown). Some of the credit for this must go to the evaluation of accident reports. For example, in the United States there were only 27 accidents to four-engined commercial aircraft between 1947 and 1951 (total aircraft authorized between 426 and 534), in which there were fatal casualties (721). The corresponding figures for twin-engined aircraft (892 to 1119 aircraft) are : 46 accidents with 523 fatalities. [1] On the other hand the roughly 1500 American aircraft in operation completed no less than 75,000,000,000 passenger miles during the same period.

However, there can be no resting on past laurels.—Excessively high demands are still made on pilots and their assistants. A good proportion of the accidents now ascribed to the pilot could probably be avoided if flying qualities were better, engines more reliable, weather forecasts more accurate, airport lighting more efficient, etc. The more difficult a task is, the more likely mistakes become. Since there are limits to the extent to which human capacities—such as intelligence, will power, endurance—can be increased, the only remaining course is to simplify flying by splitting up the work and making as many processes as possible automatic.

The commission of enquiry ascertains :

"... Probable cause of accident (belly landing by a Boeing 377 "Stratocruiser") was the captain's action in mistakenly placing the landing gear control switch in the 'up' position during landing roll."

"... Probable cause of the accident (Martin 2-0-2 crashed into flagpole) was the attempt to complete a landing approach by visual means during which time visual reference to the ground was lost."

"... Probable cause of the accident (Martin 2-0-2 ran into obstruction after discontinued take-off) was the failure of an 'Ermeto' hydraulic fitting due to improper installation."

"... Probable cause of the accident (loss of speed by a Curtiss C-46 freighter during climb) was overloading of the aircraft due to faulty loading and dispatch procedures, coupled with engine malfunctioning due to inadequate maintenance."

Four brief concluding sentences taken at random from American accident reports published during recent years. [2] They have been given here roughly in the order of the frequency of the various types of accident—landing accidents, collision and crash, take-off accidents, loss of control—and illustrate the high percentage of errors in handling.

The expression "probable cause" has been chosen so as to give utmost precision. It does not mean that the investigating commission entertains doubts as to the real cause. If insufficient evidence had been available, the commission would have stated in its conclusions that the probable cause could not be determined.

Before an accident commission issues its report it carries out a complete investigation, at least at the scene of the accident. All evidence (aircraft parts, marks on the ground) are collected, measured, photographed, witnesses are interrogated, aircraft documents and ground station logs examined, etc.

ICAO Accident procedure

For the guidance of the authorities of Contracting States the International Civil Aviation Organization has issued a "Manual of Aircraft Accident Investigation" (second edition, Doc 6920-AN/855) in English, French and Spanish. The Manual deals exclusively with the collection and interpretation of technical evidence and therefore in no way comes into conflict with the legislation of individual States. The following are important sections from the foreword to the Manual :

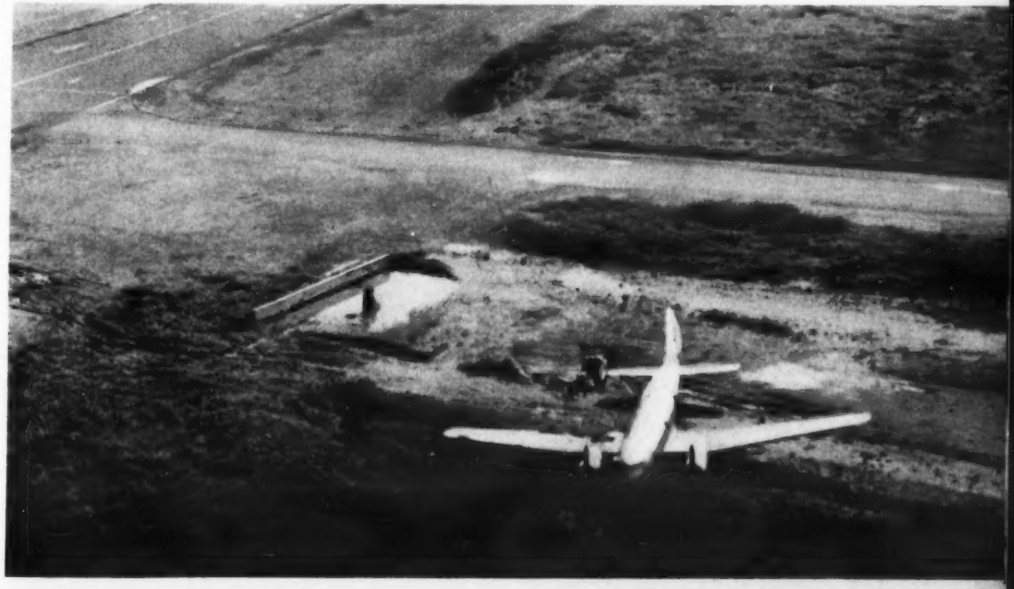
"*The investigator of an accident is faced primarily with the question : What caused the accident ?*

"Several factors must be considered in obtaining an answer to this question, among them are :

[1] From a report of the Analysis Division of the Civil Aeronautics Board Bureau of Safety Investigation.

[2] Taken from a list of 38 detailed accident reports from the aviation authorities of Burma, Canada, Denmark, Holland, Sweden, South Africa, Great Britain and USA (ICAO Circular 18-AN/15).

On August 11th, 1951, a Curtiss C-46 "Commando" with 45 persons on board left the runway at Newark Airport while preparing to take off. It ran over soft ground and collided with an obstruction, the starboard wing breaking a cable and catching fire. All the occupants were able to leave the aircraft ; the fire was put out within seven minutes (of the accident) by the foam equipment of the airport fire service. (Picture : Aircraft Accident Bulletin of the National Fire Protection Association.)



Shortly after this Mid-Continent Airlines "Convair-Liner" had taken off from Tulsa, Oklahoma, on February 27th, 1951, the port engine failed. So as not to risk running into obstructions, the pilot decided on an immediate belly landing. As the aircraft touched down first the port engine and then the whole aircraft burst into flames. However the fact that the fuel tanks in the "Convair-Liner" are in the outer wings slowed down the progress of the fire towards the cabin. All 34 occupants were able to leave the aircraft without aid. The last to appear at the doorway, where two hostesses, Miss Littell and Miss Stoltenberg, and a passenger were awaiting him, was Captain Walters. (Photo Chester Sharp.)

"Did an emergency occur whilst in flight ?

"For example was there material or navigational aid failure or did fire occur ?

"Did the pilot carry out correct emergency procedure ?

"Was the accident caused through pilot error during emergency action or otherwise ?

"Was there contravention of regulations ?

"The wreckage of a crashed aircraft may contain evidence which, if correctly identified and assessed, will allow the cause to be ascertained. Every failure, smear, scratch, tear, buckle or other damage has been made by some specific object under certain set conditions and detailed examination must be made to determine how such damage occurred. If the investigator has sufficient skill and perspicacity, the information obtained on how significant damage has been made throughout a crashed structure will enable him to reconstruct the sequence of events leading up to each individual piece of damage until, ultimately, the initial event can be ascertained.

"Unfortunately in the investigation of aircraft accidents, the investigator is faced, not only with material failure, but with other failures including the difficult problem of the human factor. It is possible to ignore all the various causes leading up to an accident, and simply treat as pilot error 'all accidents the responsibility for which rests upon the pilot'. This does not, however, recognize the fact that the pilot might have been placed in a difficult situation by other factors and that the accident might not have happened if these factors had been absent. It is therefore extremely important that in cases of pilot error the causes leading to the error, whether pilot made or otherwise, be brought out fully in the report.

"... all factors must be closely analyzed before any irrevocable decision based on false premises is made that might cause harm and not assist in initiating action for the prevention of similar accidents. The causes, and all the factors leading to the causes thereof, must be enumerated in such a way that the technicians responsible for each phase may take action to prevent a similar cause or factor being present in the future. Such an enumeration can only be achieved when a basically standardized system of investigation is carried out, using a standard nomenclature and followed by analysis and recommendations."

Collisions with birds (in this case a wild duck) can be very dangerous to sports aircraft. The windshields of commercial aircraft are as a rule stronger.

Standardization of nomenclature

The Manual gives very precise definitions of the terms to be used, of which the following are typical examples :

"*Aircraft accident* is an occurence associated with the operation of an aircraft which results in death or injury to any person or in damage either to or caused by the aircraft." (Damage to aircraft which results from windstorms, floods, hangar fires, etc., or while the aircraft is being towed are excluded from these definitions.)

Flight accidents : An accident which takes place between the time any person boards the aircraft with the intention of flight and the time all such persons have disembarked. [3]

Ground accidents. All other accidents.

Fatal injury : one that results in the death of the individual within a period of 30 days.

Serious injury : one that requires medical treatment and results in suspension of normal activities for a period of five or more days and involves unconsciousness, fracture of any bone (except fingers and toes), lacerations involving muscles or which cause severe hemorrhages, injury to internal organs, severe burns.

Minor injury : any other.

Aircraft destroyed : when the damage sustained makes it inadvisable to restore the aircraft to an airworthy condition.

Substantial damage : when major repairs or replacements and extensive investigation are necessary.

Minor damage : when the aircraft can be rendered airworthy by simple repairs or replacements and an extensive investigation is not necessary.

The Manual also defines some two hundred other terms and contains tables of technical failures, meteorological disturbances and pilot errors.

The accident investigator

The investigator must above all have a correct understanding of his task. This is not merely to "find a culprit" (the question of legal liability does not come within his compe-

[3] According to this definition accidents during the starting up of the engines before flight and during taxiing are also classified as flight accidents. Unfortunately the English edition of the Manual also classes these as *Ground Accidents*, so that we get the somewhat contradictory sentence *"a) Ground Accidents ... b) Taxying. All flight accidents which occur while the aircraft is moving on the ground ..."*

tencies), but to save lives in the future by ascertaining the real causes of the accident. As in criminal detection and medical diagnosis, the smallest and most remote details may be of the utmost importance. For example examination of blood samples in the laboratory may prove that the occupants were (or were not, as the case may be—and both are equally important) poisoned by carbon monoxide (exhaust gases), alcohol, or drugs.

The investigator must have a deep interest in his job, an avid curiosity and desire to learn all that is possible about the accident, and an analytical mind. He must be persevering, thorough, tactful and diplomatic, of the utmost integrity and have infinite patience. Finally he must rely solely on facts and avoid guess work in any form.

Above all the investigator must try to get to the scene of the accident as soon as possible, before the evidence is disturbed, to prevent unnecessary handling of the wreckage; he must set up guards and prevent fire (and theft). He must ascertain names and addresses of all likely witnesses, interrogate them at once and in detail, make a careful and systematic plan for the rest of the investigation.

No less important are the things a good investigator should *not* do. He may not rely on his memory, but should make notes as he goes along ; not release wreckage until he is sure that it will not be needed again ; not break off an investigation too soon ; never jump to conclusions ; never dismantle parts without first marking them ; never follow only one clue, but always consider all the circumstances (most accidents have more than one cause).

The investigator must also have suitable equipment for his work at the scene of the accident. Many items will be determined by the nature of the terrain (mountains, desert, heavily wooded areas, etc.), but the following must always be included :

Magnetic compass	Official seals
Measuring tape (at least 50 ft.)	Pocket mirror
Protractor	Identification and armbands
Draftsman's scale	Aircraft handbook
Writing material	Engine handbook
Tags for marking parts	Operations manual
Hand tools	Canvas sheets
Flash light with spare bulbs and batteries	Canvas bags
Maps	Ropes and twine
Containers for fuel and oil samples	Heavy gloves
Strong knife	First aid kit
Pocket lens	No Smoking signs
Photographic equipment	Marking crayons

Investigation procedure

As soon as the investigator(s) arrive at the scene of the accident (frequently at the same time as the search and rescue party) intensive work begins :

— Check whether medical attention has been obtained for the survivors ; notify undertaker ;

— Make any necessary report to local authorities ;

— Obtain names of all available witnesses ;

— Make sure aircraft is not tampered with or moved unnecessarily, and protect it from fire and other damage ; ensure also that wreckage does not constitute an obstruction to air navigation or ground traffic ;

— Set up guards to safeguard wreckage and its cargo, keep away sight-seers and preserve ground marks, etc. ;

— Brief examination of victims (photos, sketches): arrange for their identification and for medical determination of cause of death;

— Arrange for thorough medical examination of pilot and remaining crew (autopsy if required) ;

— Systematic examination of the pilot's "personal" equipment (microphone, telephone, parachute, belts, goggles, oxygen equipment, etc.) ;

— Reconstruct the seating plan of the occupants ; determine whether injuries were caused by fixed or moving parts and in what manner ;

— Check whether death occured instantaneously or otherwise (e.g. from exhaustion) ;

— Preliminary survey of scene of the accident, in particular :

a) Ground wind conditions ;
b) Obstructions to forced landings (grazing cattle, wire, ditches) ;
c) Proximity of dwellings of friends or relatives of crew ;
d) Distance from nearest airfield ;
e) Condition of ground ;
f) Ground marks and scattered aircraft parts ;

— Interrogation of witnesses ; discovering further witnesses with aid of local police and press ; (witnesses must be asked above all about the time of the accident, local weather conditions, i.e. wind, visibility, temperature, etc., about height, direction of flight and attitude of the aircraft, any signals given or parts which fell from the aircraft).

It would take too long to describe the technical investigation in detail. However it should be noted that even damaged aircraft instruments may give valuable clues, that an experienced investigator can deduce the approximate r.p.m. from the deformation of the propeller blades, that the approximate position of the aircraft at the crucial moment can be reconstructed from ground marks and the position of parts of the wreckage. Splinters of red glass for example, may indicate that the port wing tip hit the ground first.

Special attention should of course be paid to the power plant (fuel cocks, carburettors, ignition systems, propeller settings, fuels), controls, electrical and hydraulic systems.

After the third serious aircraft accident at Elizabeth, New Jersey within two months, Newark airport was closed by the Port of New York Authority. The board of enquiry into the accident (picture) found that a complete reversal of the pitch of propeller No. 3—with simultaneous failure of engine No. 4—had caused the crash, and ordered a modification in the electrical operating circuit in all propellers of the same type.

Safety first

The final report

On completion of the investigation the board of enquiry submits a report to the competent authority. An extract from this report is as a rule sent to the Accident Investigation Division of the International Civil Aviation Organization, who then makes it available to the public. The following example of an accident report, from ICAO Circular 18-AN/15 (ICAO REF ; AR/119) will illustrate better than lengthy explanations :

BURMA

Union of Burma Airways, de Havilland "Dove," XY-ABR, crashed on take-off at Mingaladon Airport, on November 22nd, 1950.

Circumstances

The aircraft commenced a normal take-off and when airborne, "wheels up" was selected. Since sticking of the undercarriage selector knob was experienced the radio operator was requested to operate the undercarriage safety switch. The undercarriage retracted normally and the aircraft immediately sank and struck the runway. The pilot shut off power and the aircraft slid at high speed for a considerable distance down the runway. The aircraft caught fire but all passengers and crew were evacuated safely before the aircraft was almost completely destroyed.

The pilot-in-command stated in his evidence that he had no idea of the airspeed at the time he retracted the undercarriage but he was satisfied that he had the safety speed. Although 'Pilots Notes' give 20 degrees of flap for take-off no flap was used in this case as the pilot felt that, in the event of engine failure after take-off, 20 degrees flap would make it more difficult to handle the aircraft on one engine. It was brought out in the evidence that in handling the undercarriage lever, which is at times awkward to operate in 'Dove' aircraft, the attention of the pilot can be distracted from actual flight.

Findings

The Board found as follows :

1. The aircraft was airworthy at the commencement of the flight.

2. The aircraft was not overloaded and the load was correctly distributed about the centre of gravity of the aircraft, despite the incorrect documentation.

3. The aircraft was pulled off after too short a take-off run at a low airspeed.

4. The undercarriage was retracted too early and before safety speed was reached, whilst still at a very low altitude.

5. The aircraft sank back on to the runway before the safety speed was reached. This may be due to either a thermal disturbance or to the fact that the pilot's attention was distracted by difficulty in retracting the undercarriage.

6. The aircraft caught fire to the rear of the starboard engine nacelle while still sliding down the P. S. P. runway, due possibly to the fracture of petrol pipes and electrical circuits.

7. The pilot failed to operate the fire extinguishers in the engine nacelles which might have prevented the outbreak of fire. (The inertia switch of the static fire extinguishers in the engine bays were not operating due to the relatively slow deceleration).

8. The airport fire tender delivered its full complement of 2,500 gallons of foam, but was late in arrival as a result of taking the unserviceable taxi track, and the equipment on it was not applied to the best advantage due to the inexperience of the crew. The fire burnt itself out and the aircraft was almost totally destroyed.

9. No loss of life or injury occured.

(Remarks.—The difficulty experienced by the pilot in undercarriage retraction was not considered to be a technical defect but merely that the pilot attempted to retract before the safety switch operated by the wheels dropping to their full travel after the aircraft was airborne, had had time to function.)

Financial Safeguards for the Air Traveller

BY JEAN T. LACOUR, DOCTOR OF LAW,

AVOCAT AU BARREAU DE GENÈVE, CHARGÉ DE COURS A L'UNIVERSITÉ

Today the air traveller takes the aircraft with an almost complete sense of safety. He no longer fears bad weather or night flying, he is no longer regarded as courageous and fearless if he takes long air trips involving the crossing of the Alps or the Atlantic. Progress in aeronautical engineering has become so every-day that it is now taken for granted. Nevertheless it cannot be denied that accidents may happen and although, taking all modes of transport together, they are relatively no more frequent than train, boat or road accidents, the air traveller should know the extent of the compensation to which he or his heirs are entitled in the event of an accident.

When commercial aviation was born, at a time when accidents were proportionately more frequent than they are today, air carriers were threatened with financial ruin in the event of an accident for which they were held responsible, since the victims, if they were important people, could frequently demand heavy compensation. This risk was increased by the fact that the relatively high cost of air travel restricted use of the aircraft to the moneyed classes. One of the commercial operators' first concerns therefore was to fix a limit to their financial liability towards their clients. A provision was therefore included in the first international air convention under private law, designed to set a contractual limit to the sums which a passenger or a shipper could claim in the event of an accident involving personal injury or damage to goods.

Thus the Convention for the Unification of Certain Rules relating to International Carriage by Air signed at Warsaw on October 12th, 1929, and ratified by 45 States gives ample evidence of this concern, and it has even been said that its essential object was to set a limit to the air carriers' financial responsibilities.

Article 22 of the Convention stipulates that the carrier's liability towards each passenger shall be limited to the sum of 125,000 French francs (francs of 1929, or "Poincaré" francs), at 65½ milligrams of gold per franc. The authors of the Convention sought in this manner to safeguard the sums they had fixed from fluctuations in the value of money, laying down that each country could convert the sums into its national currency. Today the sum of 125,000 Poincaré francs is worth, for example, roughly $8292, £2961, 35,780 Swiss francs or 2,900,000 French francs, according to cal-

culations made by the International Civil Aviation Organization.

For registered baggage and freight the maximum compensation payable is 250 Poincaré francs per kilogram ($16,60, £6, 72 Swiss francs or 5800 French francs, approximately) and for articles remaining in the care of the passenger it is 5000 Poincaré francs ($332, £118, 1430 Swiss francs or 116,000 French francs).

No air traveller or freight shipper can demand compensation in excess of the above figures except in the case of wilful misconduct by the carrier. This is an important provision since it limits claims to compensation regardless of the carrier's responsibility, with the exception of wilful misconduct or equivalent offence.

The question has now been raised of whether, in view of the reduction in purchasing power, the basic figures should not be modified.

Since the end of the last war air law experts and economists have been working on this question. They consider that, since air risks have sensibly decreased thanks to technical progress, air carriers would not suffer financially if they were made liable for higher sums of compensation.

The raising of the maximum compensation payable has been discussed on several occasions, in particular at the meetings of ICAO's Legal Committee in Mexico City in January, 1951, and in Madrid in September, 1951. The French delegation, headed by Mr. A. Garnault, proposed an increase of 30% in present figures, and this suggestion was seconded by Austria. Italy proposed an increase of 50%, whilst Canada's representative aimed at 100%. The remaining eight delegates thought there was no need to change the present limits. However, the majority stated that they would not seriously oppose a moderate increase, by which they meant an increase of 20 to 30%. At its Madrid meeting the Legal Committee decided to postpone a decision on the question of liability limits until the necessary economic information had been obtained from the ICAO Council.

The French proposal for an increase in basic rates is fully justified in view of the economic situation in that country. In spite of the fact that the Convention based compensation on the gold value of the franc, the value of the franc, even when corrected, does not correspond in France to the reduction in its purchasing power. On the other hand, as is shown by the table drawn up by the ICAO Secretariat, out of the 16 countries examined, purchasing power based on gold has increased in ten countries, decreased in five and remained stable in Switzerland. This table provides some very interesting comparative information.

Maximum Compensation

provided for by the Warsaw Convention (125,000 gold francs) compared with the cost of living

Figures supplied by ICAO Secretariat

Country	Maximum compensation for passengers (in local currency) 1929	1951	Cost of living index beginning 1951 (in local currency) (1929 = 100)	Cost of living index beginning 1951 (in gold) (1929 = 100)	Increase or decrease in purchasing power 1929—1951
Australia	£ 1,006	3,701.7	178.4	48	+ 52
Belgium	B. Frs. 176,107	414,593	378.3	160	— 60
Brazil	Cr. 40,948	153,398	432.7	115	— 15
Canada	$ 4,897	8,806	154.1	89	+ 11
Czechoslovakia	Kr. 165,292	414,593	303.9	121	— 21
Denmark	Kr. 17,274	57,273	206.4	62	+ 38
France	F. Frs. 125,000	2,902,162	2,463.3	160	— 60
Great Britain	£ 1,006	2,961	154.7	52	+ 48
Holland	Fl. 12,183	31,509	236.8	91	+ 9
Mexico	Pesos 9,825	71,124	397.7	44	+ 56
Norway	Kr. 18,274	59,228	203	62	+ 38
South Africa	£ 1,006	2,961	161	54	+ 45
Spain	Pesetas 33,280	91,915	565.9	200	— 100
Sweden	Kr. 18,274	42,910	179.8	76	+ 24
Switzerland	Sw. Frs. 25,383	35,796	142	100	0
USA	$ 4,897	8,292	151.2	88	+ 12

This explains the reason why the majority of countries consider that the system of fixing rates on the basis of gold, laid down by the authors of the Warsaw Convention, has achieved its object and that, all things being equal, there is no necessity to modifiy the maximum sums provided for.

The recent meeting of the ICAO's Legal Sub-Committee in Paris in January 1952, under the chairmanship of M. Louis Clerc, of Switzerland, again came to no decision on the question of limits and referred it back to the Council.

All this shows how great are the difficulties in the way of increasing the compensation that can be claimed by the injured party. France, who is vitally interested in obtaining an increase in compensation rates, does not intend to acknowledge herself beaten. Her representative, Monsieur A. Garnault, writing in the "Revue française de Droit aérien" (1951, p. 357 et seq.), does not hide his intention of pursuing his efforts and getting his point of view accepted. He is right.

Although it is true, in the light of ICAO's findings, that on the whole the intention of the authors of the Warsaw Convention is still being met, this does not alter the fact that the compensation sums are today too low. To value a death, whatever its economic "value," at a maximum of 36,000 Swiss francs is almost indecent. Airlines are no longer what they were in 1929. Their financial power has nothing in common with that of nearly 25 years ago. The volume of traffic and the intervention of the insurance companies should enable the rates to be increased, and economic realities would even justify an increase as great as that suggested by Canada. Moreover, it should be remembered, too, that only air transport has put a limit on its liabilities in the sense introduced by the Warsaw Convention. No other mode of transport, rail, shipping, road, has such a system of restriction of liability, or at any rate not to such a marked extent. Now technical development in aviation has been such that this limitation, in its present rigid form, is no longer justified. Moreover the increasingly widespread use of air transport should give its clients the right to take action against the air carrier in the same way as against other carriers. Since there is no question of dispensing entirely with the principle of limiting liability, the airlines should understand the inescapable necessity of making the same progress in the safeguarding of their clients' rights as they have done in the technical aspects of their operations. The airlines' economic position, too, would not suffer, since the increase in the volume of traffic enables policies to be taken out with insurance companies without excessive premiums, under conditions which protect the airlines' finances from shocks.

It is not right that, because of the inadequacy of the cover offered the client, the latter should be obliged to insure himself at his own expense or to pay a supplement on the goods he ships. Air travellers and shippers are not organized and cannot therefore put over their point of view at international conferences. However, it is gratifying to see that certain countries, or at any rate certain airlines, have recognized the necessity of bringing themselves to a certain extent in line with the practice obtaining in other modes of transport.

The "Swift" and Interavia

Sherlock Holmes to the rescue

It was one of those foggy, uninspiring mornings in late winter—or early spring—when London streets contrive to render themselves particularly unpleasant—even to Londoners.

I was still seated at breakfast, gloomily anticipating a professional call and fervently wishing I had never seen fit to become a physician. For some minutes, my friend and fellow lodger Sherlock Holmes had been standing, in languid and moody contemplation, at the bay window of our Baker Street rooms. Long acquaintance had made me familiar with the symptoms, and I was therefore not surprised when he suddenly called: "Quick, Watson, the needle!" I complied, using the usual 2 percent solution of cocaine . . .

"I say, Watson, look down there. Do you see the moustachioed gentleman approaching in our general direction? Be a good fellow and go down and open the door for him, since it is to us that he is most certainly making his way. I'll wager you a pound of Crimean caviar against a dead kipper that he is an officer from the Security Division of Vickers who—as you, Watson, are doubtless aware—are in somewhat of a turmoil because of the recent sensational disclosures concerning England's new top-secret jet-fighter, the Vickers Supermarine "Swift." You read the article, of course, in *Interavia*?"

As on so many similar occasions, I sprang from my chair to the ceiling in amazement. "Tell me, Holmes, how *do* you do it?"

"Elementary, my dear Watson, elementary! Straightforward observation shows you the man's profession; the red discolouration of the nose, plus the remarkable, I might even say sedulously cultivated, hirsute appendage on the upper lip, betrays the typical British sergeant turned night superintendant. Any further possible doubt is ruled out by the fact that the collar of his jacket is bravely decorated with the word Vickers. And finally, he is carrying the latest issue of Interavia under his arm, as you can see for yourself with the binoculars . . ."

Precisely two minutes later, Sergeant Smythe was seated comfortably in one of the fifteen well-worn leather club chairs that adorned our disorderly bachelor abode. A choice Havana between the pudgy fingers of his left hand, and a gin and bitters within reach of his right, he lost surprisingly little time in coming to the point of his visit. "Well, Mr. Holmes, what do you make of this outrageous betrayal? Think of it—Britain's enemies in full possession of highly-secret military information! Do you know what this means? Nothing less than England's downfall in World War III! Confound it, sir, Interavia has sold us out not only to the Russians and the Chinese, but to the Magyars and other satellite nations behind the Iron Curtain. I'd give my eye teeth to know how *Interavia* got hold of their information."

With his usual faintly superior smile, Holmes turned to me. "Watson, my dear fellow, be so good as to take your hat and cane and go to the Post Office. Telephone to my old friend Group Captain Hugh Dundas and tell him to come immediately. Together with this outstanding RAF officer and "Daily Express" aeronautical reporter, we will take the next train to Hursley Park. We shall delve to the root of this affair at the Supermarine plant itself . . ."

Holmes' penetrating interrogation of the gatekeeper and night watchman at Hursley Park soon led to startling revelations. The night watchman's story . . .

"I had only just finished me ten o'clock rounds. I was warming me hands at the stove in me shanty and thinking, 'shall I heat me up a good cup of strengthenin' tea or pour me out a mug of stout?' I compromised, as you might say, and decided on a quick'un of gin. There wasn't a sign of anything wrong. The firm's pride—the 'Swift'—stood fully lit up by one of them projector thingummys in Shop No. 9. And it was in full view of four guards armed to the teeth. Under constant observation, as you might say.

"Suddenly I heard an uncanny noise just outside me door. I rushed out and what do I see? A jet helicopter! It comes down just in front of the main gate and two oriental-looking blokes get out. They cover me right away with two machine-guns, and order me to hurry up and lead them to the 'Swift'. I ask you Guv'nor, what could I do? They truss up the four guardsmen, and then these blokes start to draw and note down everything about the 'Swift'. In a quarter of an hour, it's all over. Before taking off they hand me a silver rouble, saying 'greetings from Stalin and *Interavia*' . . ."

Slowly, Sherlock Holmes turned to his friend. "Now you understand, Hugh, how it is that our best, our most secret weapons, are betrayed to the enemy. See to it that your newspaper, the 'Daily Express', gets the full details right away. Moreover, Hugh, you can add that the Editors of *Interavia* offered the 'Swift' plans to the Kremlin for no less a sum than a thousand million roubles. But Molotov was prepared to pay only 700 million. In revenge, the Editors then decided to publish the details in the February number of their magazine."

(With the Editors' apologies to the late Sir Arthur Conan Doyle.)

What really happened

Life in our editorial offices on the morning of February 19th was even a little more hectic than usual. The telephones were buzzing incessantly, visitors were bumping into each other at the door.

The first enquiry came from United Press, who wanted to know if there was any truth in this story about our "spying in England." The U.P.'s director for Switzerland regarded the whole thing as a joke, but he did tell us that the "Daily Express" of that morning had come out with a big story about *Interavia*, its Editors and the "Swift" fighter, and announcing that British security officers were conducting an "urgent investigation."

Next was the Associated Press correspondent, who was equally interested and amused. Another visitor was the Central European correspondent of the "Daily Express," very courteous and almost embarrassed. The wires continued to buzz with calls from Paris, Brussels, Amsterdam and other places and, last but not least, from Switzerland.

What had happened? The London "Daily Express," which has a circulation of over four million copies daily, had done us the honour of devoting to us a banner headline, part of the front page and an editorial in its issue of February 19th. "Secret Plane Shock," the headline screamed. "*Swiss say they have British air secret*"— "Iron Curtain Gets Barred News." The lead story on the front page, under the byline of Group Captain Hugh Dundas, (also known as "Cocky" Dundas) imparted the following, remarkable information: "Air Ministry Security Officers are to conduct an urgent investigation into the publication abroad of information about Britain's new top-secret jet fighter, the Supermarine Swift. The plane, about which nothing may be written in this country, has been described in detail by the Swiss flying magazine *Interavia*—which circulates beyond the Iron Curtain. *Interavia*, published in Geneva in German, Spanish, French and English, has agents and distributing offices in nineteen different countries, including Communist Hungary . . . The Swift, one of the two new speed-of-sound fighters

By Courtesy, "Daily Express", London.

POCKET CARTOON
by OSBERT LANCASTER
"By Jove, Sir, it's jolly lucky these fellows didn't get hold of something that's actually on the operational list."

DAILY EXPRESS
No. 16,119 TUESDAY FEBRUARY 19 1952 CONTROLLING SHAREHOLDER LORD BEAVERBROOK Weather: Mainly dry Price 1½d.
THE NEWS ABROAD
Swiss say they have British air secret
Americans may by-pass Gib. in new pact
THE NEWS AT HOME
Homes spurt possible under new order
Firm returns cash to 'best buyers'
SECRET PLANE SHOCK
Cabinet talks last till midnigh
Mother killed on way
NEW HOMES SPEED-UP
Details of secret British jet fighter published in Swiss magazine
Iron Curtain gets barred news
'TAKE A BACK SEAT' PLAN FOR GIBRALTAR
AIR Ministry Security Officers are to conduct an urgent investigation into the publication abroad of information about Britain's new top-secret jet-fighter, the Supermarine Swift.
The plane, about which nothing may be written in this country, has been described in detail by the Swiss flying magazine Interavia —which circulates beyond the Iron Curtain.
Interavia, published in Geneva in German, Spanish, French, and English, has agents and distributing offices in 19 countries, including Communist Hungary.
CONTINENTAL DAILY MAIL
'Leak' of RAF jet secrets in Switzerland
DETAILS REVEALED BY MAGAZINE
Un dessinateur hollandais avait reconstitué les plans d'un prototype britannique
IL N'EXISTE PAS DE SECRETS MILITAIRES pour les rédacteurs des revues d'aviation
En page 7 : LE COMPTE RENDU STÉNOGRAPHIQUE DU PROCES DE P
L'AURORE
France libre
MORE AIR SECRETS SOON, SAY TWINS
The Daily Telegraph
Suisse
Le journal du matin
Après les divulgations de la revue « Interavia »
UNE REVUE SUISSE publie les plans du chasseur supersonique anglais "Swift"
Les entretiens de Londres
L'étrange histoire de Marie Besnard
Un secret de l'aéronautique anglaise dévoilé (!)
TWINS LAUGH AT JET SECRETS
HOW THEY FOUND THEM
« INTERAVIA » N'A RIEN PUBLIE DE SECRET
JOURNAL DE GENÈVE
L'émotion aux Communes après la divulgation de secrets sur le supersonique chasseur britannique
NEW YORK Herald Tribune
European Edition Published Daily in Paris
PARIS, TUESDAY, MARCH 4, 1952
Begins Consultations
Foreign Aid Is Linked to N.H.
Taft Starts Tour
37 Die in Crash at Nice

ordered for the RAF last year, is Britain's answer to the MiG-15. In this country, the only information that can be given about the Swift is that it exists in prototype form. But *Interavia* gives minute details of construction, engine mounting, dimensions, radio equipment and fuel capacity. It even describes the plane's armament which, it says, represents an 'almost revolutionary' improvement on the 20-mm cannon which for the past eleven years have been standard in all RAF fighters . . ." And so on in the same vein.

The editorial comment on Page 4 reverts to the theme, and the British Air Marshals are accused of all sorts of sins. In particular they are blamed for having "miscalculated badly," because the "Swift," today's answer to the MiG-15, will be in service only in two years, by which time "the MiG-15 may be old stuff..." (Nobody can blame us for that, anyway).

Next day the paper reverted to the theme with Osbert Lancaster's pocket cartoon, reproduced herewith, which bears the caption: "*By Jove, Sir, it's jolly lucky these fellows didn't get hold of something that's actually on the operational list...*"

Then the French newspaper "L'Aurore" really went to town. Part of the front page of its February 21st issue and about half of page 3 dealt with the incident: "Anxiety in the RAF, a Dutchman has 'reconstructed' the Swift... another episode in the cold war..."

The blurb in the "Daily Express" was followed by the rest of the press, from Melbourne's "The Herald" and "The Age" to the "New York Times" and the "New York Herald Tribune," from Johannesburg's "Star" to Stockholm's "Svenska Dagbladet," from West German newspapers to Upper Wallop's "Evening Wail." The horror-stricken man-in-the-street discovered how secrets of the West are being made accessible to the East and how a seemingly harmless group of editors were undermining the British Empire...

Fortunately there were still some people who looked at the thing reasonably and couldn't understand the fuss. Aviation experts found it difficult to suppress a smile. So did we, as a matter of fact, and we hope we did not hurt the Group Captain's journalistic pride.

The facts

We do not cover the title page of our publications with modest phrases like "the most influential aviation magazine in the world," or "the best" or the "most widely circulated," but we feel that we are compelled to talk about ourselves for a change. What we are doing is to report as quickly as possible, as precisely and as fully as possible. It is our aim to serve aviation, to illustrate our stories with good photographs, and to arouse interest with our writing. From time to time we also call a spade a spade. In the course of many years this policy has brought us many friends in many countries and also a number of enemies. So far we have not had the privilege of meeting the Group Captain of the "Daily Express," and for the time being we do not count him among our enemies. No doubt he wrote his story as part of what he regards as his journalistic duty, and he contributed a sensation to a sensation-loving paper. That we have friends also in England was proved to us in the New Year's letter of an old and very well-known reader: "... In your No. 1 issue for 1952, on which I congratulate you, you have maintained your standard of production as the most magnificent air publication in the world..." Many thanks.

One implication we have to reject, however. While it is true that we always endeavour to publish the latest details and figures as accurately as possible in order to make our articles worth publishing at all, we have never printed sensational material merely for the sake of sensation, nor have we or shall we ever snoop around for secret information. It is best to explain our meaning with a concrete example:

The August-September 1950 issue of *Interavia Review*—which appeared shortly after the beginning of the war in Korea—carried an article entitled "Travelling Along the Fringe of Soviet Air Power." The contents were not sensational, neither pro- nor anti-Russian. In a special box it featured a drawing and a brief description of the MiG-15, the now famous Russian fighter, which at that time was practically unknown to the Western public. This brief story on the MiG-15 we considered to be of topical value, but the daily press picked it up and turned it into a sensation.

A technical artist living on this side of the Iron Curtain had, in July 1950, sent us a drawing captioned "the Russian Yak-21 jet fighter." Our technical collaborators thereupon dug up all the information they had on earlier Yak types and were doubtful. Just before going to press the Technical Editor said that this could not be the Yak-21... He was quite positive: this was the new MiG-15, the existence of which had been rumoured... and which turned up on the Korean front months later, at the beginning of the 1950-51 winter. Incidentally, this same MiG-15 was dealt with subsequently in a patronizing and even derisive way in aviation circles and the aviation press. But events ultimately proved us right when we stated at the end of our MiG-15 description (*Interavia*, No. 8-9, 1950, p. 432):

> "A conservative performance estimate, based on the lay-out and assuming 5,000 lbs. thrust output, would make the Russian fighter considerably faster than the de Havilland Vampire, Gloster Meteor and Republic F-84E Thunderjet, maximum speed possibly being as high as 690 m.p.h. (Mach 0.91), with comparable climb and ceiling, better roll-rate and combat manoeuvrability, lighter weight and inferior range. At medium altitudes it would probably acquit itself well in combat with even the latest versions of the North American F-86 "Sabre" and could almost certainly reach and fight Convair B-36 and Boeing B-50 bomber formations."

The things we had figured out or invented in July 1950 have since been fully confirmed by official authority in Washington, London, Australia and elsewhere.

In the normal course of events we would not have reverted to this fact, but today we feel that it serves to show that we had scored a bullseye with our work and observation. We had not endeavoured to betray any secrets, but we had simply been pursuing our usual policy of thoroughness. That is our duty.

It is not very difficult to describe an aircraft type on the basis of handouts from the manufacturers. The result is that a hundred aircraft are described in exactly the same way. From the point of view of advertising revenue it might even be useful to claim that each and every aircraft is the best, the fastest, most modern, most effective, most comfortable and most beautiful. In our opinion, however, this is not reconcilable with the duties of a responsible aviation press.

Now, a description of the Vickers-Supermarine "Swift" fighter was scheduled to appear in the February 1952 issue of *Interavia Review*—which has "agents and distributing offices in 19 different countries, including Communist Hungary" and which probably also circulates in the Soviet Union. It is impossible—and "Cocky" Dundas should be aware of the fact—to prevent any interested reader, regardless of his nationality, from buying newspapers and periodicals which are offered for sale in London, New York, Paris, Bonn, Zurich, Stockholm, Rome, Madrid, Johannesburg and elsewhere. This applies to us, to the London "Times," and even more to the "Daily Express" with its high circulation.

We also believe that any technician or technical draughtsman could have gone to the trouble of studying the information, photographs and drawings released and authorized by the British Air Ministry and Ministry of Supply concerning the Vickers-Supermarine "Attacker" of 1946, the Vickers-Supermarine 510 of 1948 and the Vickers-Supermarine 535 of 1950. He could have compared them with the three photos of the "Swift" which were officially released last August—and he would have known as much or as little as we do. In view of numerous similarities in the origin and evolution of these types, any aeronautical engineer could have arrived at certain conclusions and written a plausible story on the latest member—if it *is* the latest—of the Vickers-Supermarine fighter family.

Our technical editors did just that. What objections can anybody raise?

At about the same time a Dutch technical artist who had previously worked for us offered to supply us with drawings he was preparing of the "Swift." No doubt we could have done them ourselves, but editorial offices are always pressed for time, and so we accepted the Dutch offer. Our technical people made a few minor corrections to the drawings and sent the whole lot to the printers.

It never occurred to anybody that to print a story based on obvious facts could be interpreted as a divulgation of top secrets. If there had been any intention of this sort, these editorial offices and their chief would have been forced out of business long ago—the Swiss authorities can be very, very fastidious. As it is, *Interavia* has existed for 19 years. Furthermore, if ulterior motives had guided us it is hardly likely that publication of the story would have been chosen as the appropriate vehicle...

This should clarify our position. But we would add that on February 28th Parliamentary Secretary to the Ministry of Supply, Brigadier Austin R. W. Low, implied in a written reply in the Commons that the article in question had divulged no secrets.

We consider the Vickers-Supermarine "Swift" jet fighter as a remarkable product of the British aircraft industry and we felt that we should write about it as soon as we could. If this publication was a tribute to the ability of the manufacturers, we are glad to have had an opportunity of paying it.

E. E. H.

Under the Joint Army Navy Machine Tool Programme (JANMAT) the U.S. Government stored thousands of World War II machine tools at the former Bell bomber plant at Marietta, Ga., and the former Martin bomber plant at Omaha, Neb. This photo shows the extent and variety of the machines "mothballed" at Marietta.

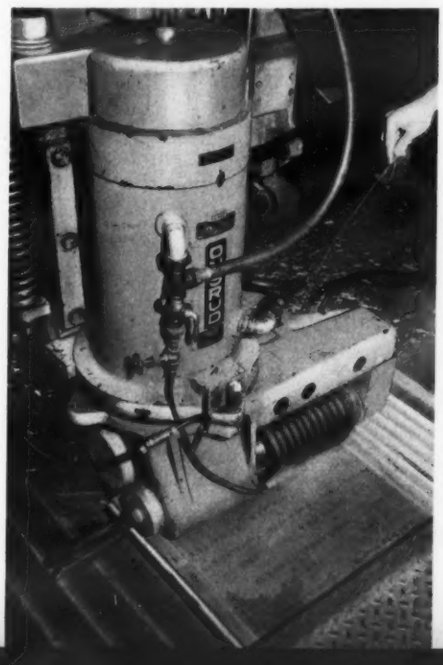
Machine Tools for Defence

Production bottleneck

Little known or discussed by the general public, the machine-tool industry is the basis of the West's, and particularly America's, standard of living and its power for defence. Today, vital aircraft production goals are not being met because of the scarcity of high precision parts badly needed by aircraft and engine manufacturers.

The deficiency stems from a problem which is fundamental to the rapid expansion of a complex industry. Under normal peacetime conditions the manufacture of machine-tools in America—and elsewhere—is a relatively small, compact, prosperous industry making the tools required for the mass-production methods which make possible the material side of the famous "American Way of Life": automobiles, refrigerators, washing machines, radios, television sets, etc. In military emergencies, resulting in steeply increased demands for machine-tools for the production of the latest types of weapon, this industry can never cope with its orders within the desired delays, although in the long run it will always catch up. Once again this fact has been proved by the Korean emergency and the rearmament programme it touched off: American leaders quite openly admit today that aircraft production is behind schedule, and to a large extent this is so because the machine-tools needed for modern manufacturing methods are simply not available.

Close-up view of one of the cutting heads of Lockheed's Giddings & Lewis skin mill mounted with a "gang" series of carbide-tipped milling cutters. The milling cutters are 8 to 10 inches in diameter and can be mounted in a series up to 12 cutters wide. Mounted on a horizontal arbor, the cutters here turn at 3,600 r.p.m. while "sculptoring" integrally-stiffened airframe panels from Reynolds Pureclad aluminium alloy plates.



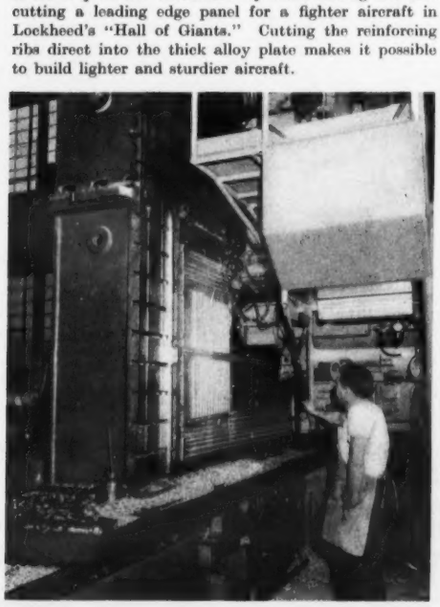
The immense significance of machine tools in aircraft production was dramatically brought home to the U.S. Army Air Forces ten years ago, according to a story which appeared at the beginning of last month in "Time," the U.S. news weekly. "Time" relates that Air Force engineers had discovered in 1942 that engine mounts, wing spars and other parts of German wartime aircraft had not been made by slow machining or welding, as were those in U.S. aircraft. They had been quickly forged in one big piece, apparently by enormous hydraulic presses that dwarfed any in the world. After VE day, a U.S. technical mission in Germany raced the Russians to grab the presses. The

Another view of Lockheed's $450,000 Giddings & Lewis skin mill giant machine tool designed for the manufacture of self-reinforced aircraft "skins." The machine can mill skin panels up to 10 feet wide and 32 feet long from solid or rough-forged alloy plate, permitting use of thinner wings and sharper fuselage required for the high-speed aircraft of the future.

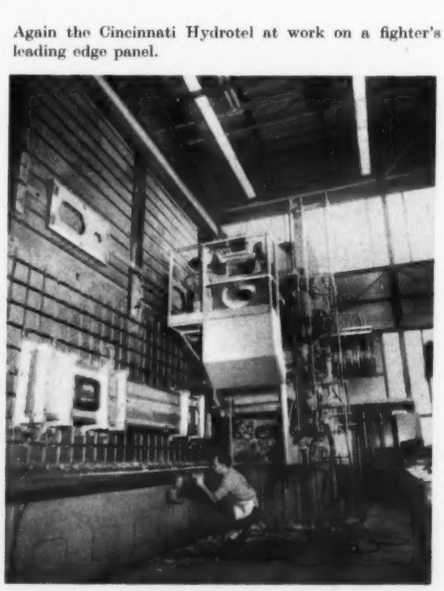
U.S. got two exerting a forging pressure of 16,500 tons, but the Russians snatched the world's largest, a 33,000-tonner. They put it to work and started building an even bigger one, a German-designed 55,000-tonner. But it was only at the end of February of this year that the USA's own big-press programme at last got into high gear when a House subcommittee okayed an Air Force programme to spend $389,000,000 on 20 large forging and extrusion presses. Under this programme, Henry J. Kaiser, the versatile industrialist, will operate a 25,000-tonner and a 35,000-tonner to be built by E. W. Bliss for $14,000,000, at a new $17,000,000 plant at Newark, Ohio. Aluminum Co. of America will get a 35,000-tonner and a 50,000-tonner to be built by United Engineering & Foundry and Mesta Machine. Two more will be operated in California by Harvey Machine Co., and the Dow Chemical Co. may also get one for magnesium forgings. When some of the twenty presses start operating in mid-1953, they will mass-produce vital aircraft parts in much the same way as automobile parts are now turned out, and they may save as much as 10 percent of the cost of airframes—or, as "Time" says,—"in the present big programme, billions . . ."

But more serious than the lag in *airframe* production is the fact that the new and complicated *power plants* of modern military aircraft cannot be turned out in the required quantities. Here again, the reason is that engine manufacturers do not have enough machine tools to meet the vastly expanded production needs. American jet engine manufacturers alone could use the entire output of the nation's present machine-tool production capacity. Last autumn the rate of tool production in the USA was about $700,000,000 a year, but by the end of 1951 machine-tool orders totalling $3,000,000,000 had been placed for defence production purposes *alone*. While tools are now being delivered to the defence plants, it is clear that the industrial problems created by the machine-tool shortages cannot be easily relieved.

A close-up of the Cincinnati Hydrotel milling machine cutting a leading edge panel for a fighter aircraft in Lockheed's "Hall of Giants." Cutting the reinforcing ribs direct into the thick alloy plate makes it possible to build lighter and sturdier aircraft.



Again the Cincinnati Hydrotel at work on a fighter's leading edge panel.



Who invented machine-tools ?

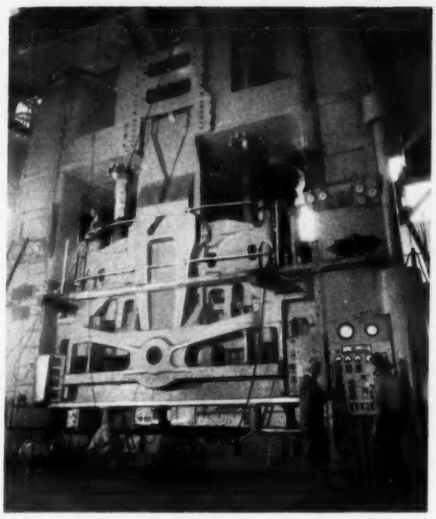
What is the machine-tool industry and what part do machine tools play in this day of precision manufacture? Machine-tools are nothing more or less than the "carpenter's tools" of the metal working industry. They cut, drill, grind, shave and shape metal as the carpenter's saw, brace, bit, sander and plane are used to work wood. In America, 250 firms are producing machine tools, yet they form only a small component of overall industrial activity.

Machine tools date back nearly to the beginning of humanity. The ancient Egyptians used a kind of primitive drilling machine and the oldest German lathe was built in 1400; towards the end of the 15th Century Leonardo da Vinci designed a lathe using a flywheel. Practical lathes were built in France two hundred years ago. In England, some 25 years later, John Wilkinson developed the boring mill which touched off a wave of machine-tool development. In rapid succession the planer, the shaper and modern lathe were invented, and by 1800 the American Eli Whitney had conceived and put into practice his system of manufacturing interchangeable parts in the production of muskets for the U.S. Army. Whitney demonstrated that a machine-tool could fashion thousands of parts, all alike and indistinguishable from one another. The company of which he became the co-founder, Pratt & Whitney Co., has long been one of the best-known machine-tool makers in the USA and is the parent of what today is the Pratt & Whitney Aircraft Division (engine makers) of United Aircraft Corporation, though the two organizations are now entirely unconnected.

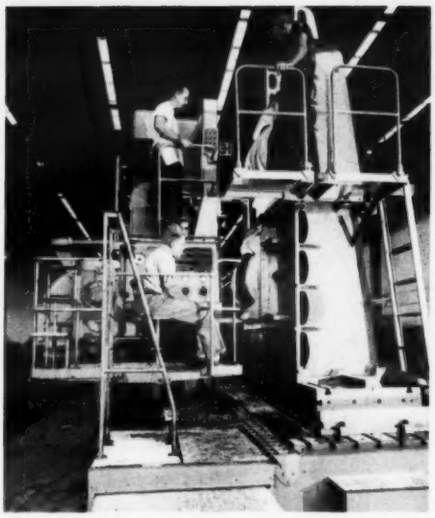
"JANMAT"

Nobody in America would say that the present, tight machine-tool situation is hopeless, however, for there has been much study and planning for expanded military production requirements. A large part of the bottleneck arises from the introduction of new and much tougher materials particularly in the case of jet engine production.

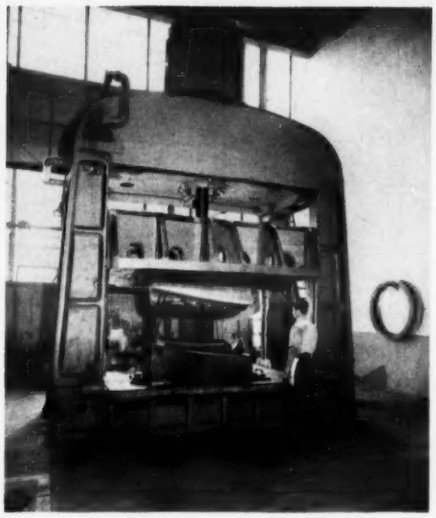
In anticipation of this situation and at the instigation of the USAF, the U.S. Government set up the so-called *Joint Army-Navy Machine Tool Program* (JANMAT) immediately after the end of the last war. When Government contracts were terminated, surplus machine-tools were bought up by the Government and two huge machine-tool depots set up in the former Bell bomber plant at Marietta, Ga. (now used by Lockheed for the production of Boeing B-47 jet bombers and Lockheed T-33



Close-up view of Lockheed's multi-purpose 8,000-ton hydraulic press, the largest at present in the U.S. aircraft industry (even larger ones are coming along, though). Versatile operations of the press include draw-forming, stretch-forming, stretcher-levelling, and high-pressure rubber forming. Design specifications were worked out by Lockheed engineers to enable the company to fabricate larger and stronger one-piece airframe parts, eliminating the need for thousands of rivets and support pieces.



The Keller duplicator machine traces pattern on upper level with stylus—while the lower level cutting tool makes a reproduction of the model in alloy metal. This machine performs vital functions in Lockheed's Hall of Giants battery of king-sized units which produce the one-piece integrally-stiffened construction now going into current model aircraft at the Burbank, California plant.



Lockheed's 20-ton Cecostamp press which has a capacity for sheets up to 10 feet long by 8 feet wide. A Kirksite die and lead punch are generally employed, although both die members are sometimes made of kirksite. The machine is mounted on a solid concrete "inertia" block, 16 feet high, which floats on springs. No vibration is felt on the surrounding shop floor when blows are struck, even though the impact be twice that exerted by conventional drop-hammers used in the aircraft industry.

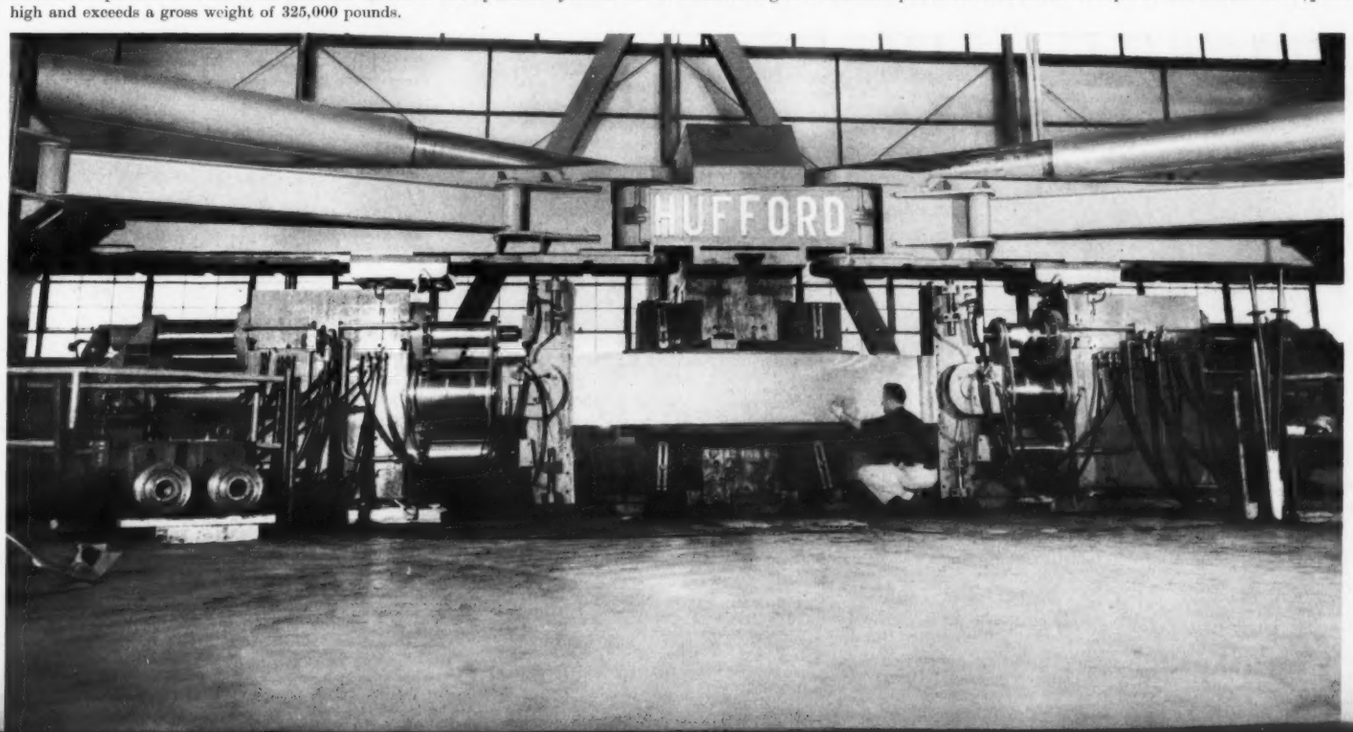
jet trainers) and in the wartime Martin bomber plant at Omaha, Neb. Under the present emergency, about 1,700,000 machine-tools had been diverted to aircraft and other defence production by last December, and some 35,000 of these were among those stored after VJ Day under JANMAT for future aircraft use. Unfortunately, many of them were found unsatisfactory or obsolescent because they were not precise enough to handle today's complex aircraft and engine parts.

Even so, the Air Force's theory of storing machine tools paid off handsomely in getting the expanded military aircraft and engine production rolling. Manufacturers who would otherwise have had to wait for delivery of new machine-tools were able to select grinders, milling machines, lathes, drills, routers, press brakes and screw machines from the stocks for which USAF Air Materiel Command was housekeeper. As soon as the prime contractors had the necessary production space, the tools were shipped to them, but ownership was retained by the Government. Upon completion of contracts (which is not likely to be until the end of the present emergency), it is planned that the tools be returned to the Air Force pool.

Other plans and projects

In addition to the bottleneck-breaking programme of the Aircraft Production Board, other means are being employed to speed the tool procurement programme. Curtiss-Wright Corp., for example, has been buying machine tools in Switzerland (the Oerlikon Machine Tool Works, Bührle & Co., of Zurich, and others have received orders running into millions of dollars), as well as in Italy, Germany and elsewhere in Europe, acting as buying agents not only for themselves but for the Air Force, for use by all military contractors. Curtiss-Wright Corp.'s direct competitor, the big United Aircraft Corporation, has also gone to Europe, and the first of some 74 new machine tools purchased from European manufacturers during 1951 are already at work at the engine plants of the Pratt & Whitney Aircraft Division. Nevertheless, the

Heavy skins, armour plate for jet aircraft, stringers and extruded materials can easily be handled by Lockheed's 200-ton Hufford stretch-wrap forming press. Sheet stock up to 24 ft. long and 6 feet wide can be accommodated, as well as extrusions of the same length. All movements of the machine are hydraulically actuated through remote controls located in a pedestal in front of the machine. Either of two hydraulic cylinders can be actuated to give a maximum pull of 200 tons on the work piece. The machine is 17½ feet high and exceeds a gross weight of 325,000 pounds.



Looking up at the control cab and structural members of the new 30-ton multi-purpose crane in Lockheed's Hall of Giants. Crane can be moved left to right from bay to bay in the building through the aid of electrically controlled "cross-overs." Unit will also roll the length of the building on railed bridges.

total contribution from Europe is small (and, paradoxically, the USA also supplies machine-tools to European countries under the Marshall Plan !), but it is extremely important because in many cases it has permitted production to get under way in advance of the delivery dates quoted by American manufacturers.

A novel plan is that evolved in Los Angeles by the U.S. Industrial Tool Company, which makes its large inventory of machine tools available to manufacturers on a flexible rental plan by the day, week or month. Thus, some subcontractors for the aircraft industry with small shops can avoid tying up cash in tooling which would stand idle when the job is completed. It gives shops of all sizes the run on a $10,000,000 tool crib.

While these measures are certainly useful, any large-scale speed-up in aircraft, engine and equipment production ultimately still depends on the completion of the substantial machine tool procurement programmes that have been initiated by all the large aircraft manufacturers. *Interavia Review* has had the good fortune to obtain details of the programmes now being carried out by two large U.S. manufacturing concerns on the U.S. West Coast, one of which is a prime contractor, whereas the second is, to a large extent, a subcontractor. The first is the huge *Lockheed Aircraft Corp.*, of Burbank, Los Angeles, makers of commercial and military transports, jet fighters and trainers, and large patrol bombers ; the other is the *Ryan Aeronautical Co.*, of San Diego, Cal., manufacturers of "Navion" private and liaison aircraft and specialists in sheet-metal component production.

Heat oven (left) and Degreaser tank (right) in Lockheed's Hall of Giants. Heat treatment basket in place below oven, and above quench tank, lower left. Mobile degreaser basket directly in front of fume chamber, upper right. Degreasing process is accomplished by trichlorethylene fumes rising from tank at bottom of the unit.

"Hall of Giants"

Lockheed has just put into operation a number of machines more massive and more powerful than any ever used before in aircraft manufacturing under what the company calls "its policy of providing machines to match its men." These outsize tools have been installed in a special building, known as the "Hall of Giants." The fact that the plans for this Hall and its battery of extra-large milling, forming and drawing machines were initiated soon after World War II is proof of the company management's foresight. It enabled Lockheed to set machine-tool builders to work on its new ideas at a time of normalcy in the machine-tool industry. Events have subsequently shown that delay of only a year or two in reaching the decision to invest millions of dollars in the new machines would have now involved the company in waiting periods of three to five years ! As it is, Lockheed is confident that its plant is equipped to keep pace with airframe design beyond 1965, since its giant tools are large and powerful enough to handle the biggest components and strongest aircraft metals expected to be developed by that time.

Designs for machines capable of turning out the strong, relatively thin structures needed for present and future aircraft were specified by the company's own engineers, because no standard machine-tools were considered adequate. Several of the machines are the result of joint design projects between Lockheed and the machine-tool builders.

The newest manufacturing process in airframe construction—integral stiffening of components—was pioneered by Lockheed and lends itself to one-piece construction of large parts, such as panels and leading edge sections of wings, which formerly required countless numbers of rivets and support pieces. Considerable savings in production costs are made possible by the new giant machines, because they can do the job in less time with a major reduction in the number of tools, jigs, pieces and man-hours of labour. Fabrication costs for the individual piece will be higher, but detailed assembly work will be largely eliminated, which will result in an ultimate reduction in over-all costs.

The "Giants"

Lockheed's "Hall of Giants" at present houses more than $5,000,000 worth of large machines, in addition to lighter equipment. The giants installed are the following :

. *A Giddings & Lewis* skin mill, the only machine of its kind in the American aircraft industry today, for major cutting operations. Principal parts milled by this dual-purpose machine include : integrally-stiffened inner wing panels on military versions of the "Constellation" transport and one-piece skins for the wings of F-94 all-weather jet interceptors. Stiffening of "Constellation" outer wing panels is slated to come on later models. An example of the weight savings made possible

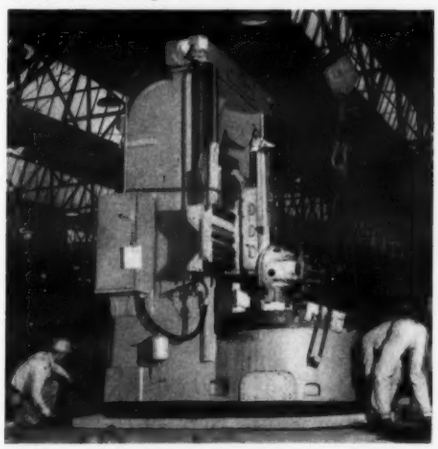
through integral stiffening is the 325 lbs. gained on the lower surface of the inner wing of the "Super Constellation" alone. The skin mill can cut, taper and profile sheets up to 10 ft. by 32 ft. The Giddings & Lewis, which combines the effectiveness of two machines (milling and profiling formerly required separate machines), cost $400,000. It is 18 ft. high, 30 ft. wide, 80 ft. long and weighs 200 tons. In operation the massive new machine tool automatically cuts, edges and shapes a desired pattern in three dimensions in one surface of a metal plate. A two-dimensional electronic tracer controls the cutting pattern laterally and longitudinally according to a master pattern, while a vertical milling head cuts the surface to varying thicknesses, operating in three dimensions with two feed motions ; the feed range for cutting is from three quarters to 150 inches per minute, with infinite intermediate speeds. Each of the three milling heads is powered by a 100 horsepower water-cooled motor, considered the most compact power unit of its type. The machine has twelve drive motors, totalling 350 h.p., exclusive of 18 motors and generators that deliver the power supply. Special carbide-tipped cutters,designed by Lockheed for specific operations on the machines, vary in type and size according to the job to be done. The cutting action creates a storm of aluminium chips which are blown on to a belt system conveying them to large elevated hoppers outside the building at the rate of two to three barrels of flakes per minute. An air-conditioned underground control room contains all the electronic and electrical relaying equipment, as well as four sets of motor generators which supply the power to the motors.

The big *Cincinnati Hydrotel,* rated the largest of its type, is another cutting machine in the Hall. It is principally employed for machining structural aircraft parts of odd-shaped contours from forgings, as well as integrally-ribbed sheets. The cutting movements of the Hydrotel are controlled by an overhead tracer unit which automatically follows the contours of a master template. A vertical angle plate, twelve feet high and fourteen feet long, holds the template and parts in place. Cost of the machine installed was $150,000.

Another giant is the huge *Keller duplicating machine,* used primarily to manufacture steel or other dies. Purpose of the Keller is to save the long hours of grinding time on castings, by producing an exact replica from a stylus-traced model. The machine costs $95,000.

Three types of forming machine are used in the Hall—draw, stretch and impact. Drawing operations are handled by the multi-purpose 8,000-ton *Birdsboro press,* the largest triple action hydraulic draw press in the world. Representing an investment of $825,000 and two years of negotiations and specifications with manufacturers, this giant towers 36 ft. above the factory floor from a base embedded 12 ft. below floor level in a steel-reinforced concrete foundation. The bed of the press measures 31 ft. by 10 ft. and weighs nearly 1,200 tons. The Birdsboro is used to handle heavy-gauge, high-strength aluminium alloys and stainless steel in large sheet sizes. It enables the manufacturing department to form large sections of integrally stiffened skin, as well as much larger heavy gauge conventional panels. All this results in a reduction of the number of rivets, splices and support pieces and therefore saves valuable weight to compensate for the new equipment which is constantly being added to modern aircraft.

The first of four mammoth Warco presses is being installed at Ryan's San Diego factory. Heavy steel piles were sunk 60 feet to provide rock-like foundations for the behemoth. The machine will be used to stamp out jet engine components from stainless steel—like pressing cookies out of dough.



Part of the $2,500,000 worth of tools going into Ryan's San Diego factory : a towering Bullard vertical turret lathe.

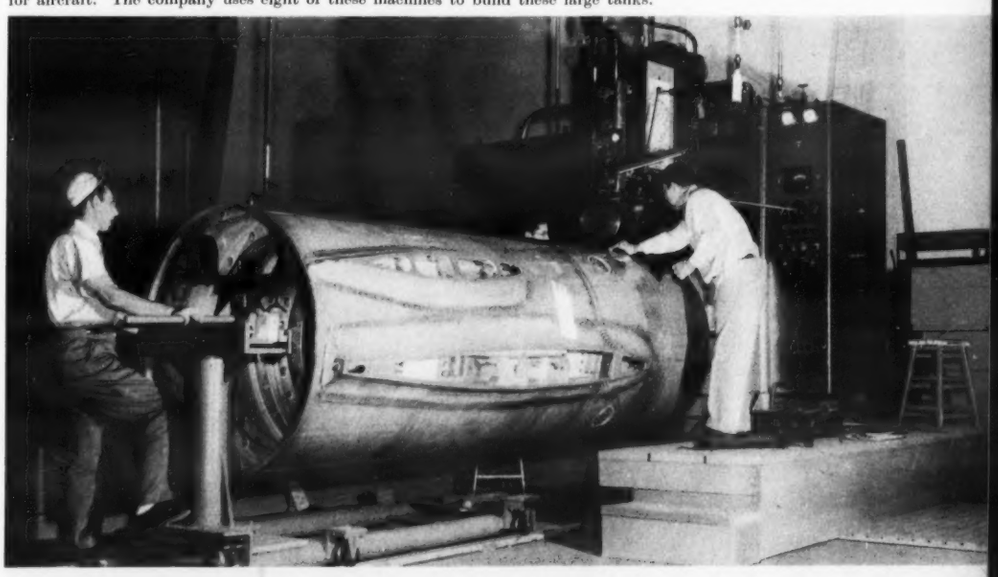
Heavy skins, armour plate for jet aircraft, stringers, large contoured skin panels and extrusions are handled with ease by the Hall's 200-ton *Hufford stretch-wrap forming press,* installed at a cost of $325,000. Sheet stock up to 24 ft. by 6 ft. can be accommodated, as well as extrusions of the same length.

Difficult impact-forming of high strength aluminium alloys and sheets of stainless steel can be accomplished readily on the 20-ton *Chambersburg Ceco drop hammer stamp press.* The ram of this giant will lift a 20-ton die. The machine has a capacity double that of the previous largest stamp. The cost came to $150,000.

Most of the parts and pieces fabricated in the "Hall of Giants" are subject to treatment by processing equipment valued at $200,000. This is located in the north-west corner of the building. A large oven above the floor level and its accompanying quench tank below take care of the heat-treatment phase of metal parts necessary in forming operations. As a final operation, before routing to various assembly lines, all parts are subject to a vapour bath in a giant trichlorethylene degreaser ; for this purpose they are placed in a large metal basket which moves in and out of the unit. This removes all lubricants picked up by the material in the process of fabrication.

Special trimming mills, high speed bandsaws, a 30-ton capacity die loader, a 30-ton overhead crane and numerous standard tools complete the equipment housed under the roof of the Hall of Giants.

A new Federal seam welding machine, largest of its type, is employed at Ryan to seam weld large external fuel tanks for aircraft. The company uses eight of these machines to build these large tanks.



Like sections of a big torpedo, these smooth fuel tank sections are being assembled in the Ryan final assembly department. Completely seam welded into one continuous, smooth surface, the exterior of this tank has no rivets to mar its aerodynamic cleanness.

Ryan's smaller "Giants"

Ryan Aeronautical Co., of San Diego, aircraft builder in its own right (it used to build naval fighters and trainers and still produces the "Navion" private and liaison aircraft in quantity), has long made itself a name as a specialist in the production of welded stainless steel and aluminium components. Since the outbreak of the war in Korea, the company's subcontracting business has increased enormously, and to cope with the work Ryan has ordered a total of more than $2,500,000 worth of modern machine tools. By the end of 1950 only about $1,000,000 worth of equipment had been installed. Some of the machines are of entirely new types, since the Company is engaged in the manufacture of jet engine components consisting of a combination of sheet metal parts and precision-machined members.

Typical examples of these new machine tools are some of the largest lathes, multi-purpose cutting machines and forming tools in existence. The company has installed a massive *Giddings & Lewis boring, drilling and milling machine* which weighs nearly 10 tons and combines three important metal cutting tasks in one unit. Costing $31,500, it can handle unwieldy structures with high precision and is used for the manufacture of jet engine parts and tools for jet engine production.

Ryan has a bank of six big *Bullard vertical turret lathes* installed and on order, including the largest boring mill with raised bed ever installed on the Pacific Coast. With a fast whirling table, operating up to speeds of 160 r.p.m., this 32-ton giant stands 13 ft. high. Jet engine exhaust cones, external wing tank sections and other large structures are machined on this tool. On critically short machines, such as the vertical turret lathes and radial drill presses, work is scheduled on three daily shifts, six days a week, to make maximum use of the machine facilities. Only on Sundays the machines are stopped for necessary maintenance work.

Better welding

Rapid progress has been made by Ryan in its own chosen field, namely that of *welding*. Ten years ago standard spot welding equipment was capable of developing only 40,000 ampères on short circuit and exerting 1500 lbs. of pressure between the electrodes. The new *Federal and Thomson welders* give operatives unmatched "fire power" and precise "fire control." They squeeze metal sheets together with a force of 9,100 lbs. and can "fire" 120,000 ampères across a short circuit. This terrific power can stitch together two steel sheets one-quarter of an inch thick or two aluminium alloy sheets one-eighth of an inch thick.

The most striking improvement in spot welding machines has come about in the electronic control which "tells" the machine what to do and when to do it. Spot welding is a sequence affair requiring the rapid application of exact amounts of pressure, heating and cooling. The control individually delineates the periods allowed for "squeeze," "weld," "forge" and "off" phenomena and cramps the whole cycle within a half-second of time, at the rate of 120 spot welds per minute. These controls "think" and act in terms of thousandths of a second. Many of the new features of the modern welding machines in use at Ryan were specified by company engineers.

A good example of the type of product that can be built with present machines are the huge external wing fuel tanks which the company is making in quantity under sub-contract. They are fabricated with seam-welded joints in which rotating electrodes produce a series of overlapping spot welds to form gasoline-tight seams without the need for sealing compounds or a single rivet.

Not long ago, spot-welding would not have been considered for building such primary structures as floor beams for cargo aircraft. Today the company is making complete sets of 49 floor beams for each Boeing C-97 "Stratofreighter" cargo carrier. One thousand spot-welds are placed in each "I" beam assembly to form one of the lightest and strongest aircraft members. In the jet engine field, Ryan uses spot welding to form combustion chambers and transition liners of Inconel, and cone and tail pipe assemblies of stainless steel. The stainless steels and nickel base alloys are well fitted for spot welding because their high electrical resistance makes short heating times possible. Operating at great temperatures, these engine components are vital parts whose failure could cause the loss of an engine or an aircraft.

*

These typical examples of the U.S. aircraft industry—one a prime contractor, the other a large subcontractor—illustrate the leading role played in the defence effort by machine-tools, which in our age of mechanized war and peace have become the key to production. In spite of certain exceptions—one of them was mentioned in "Time's" story—America is the undisputed machine-tool queen among the nations, and this enabled her and her Allies to win World War II: for during the last conflagration she built and supplied machine tools not only for her own needs but also sent quantities abroad to the United Kingdom and the Soviet Union. Once again she has settled down to the grim task of building up her own defences and those of her Allies. That she will finally succeed in outproducing anyone else is a foregone conclusion, and one major reason for this is the fact that she possesses the world's vastest experience in the design and manufacture of machine-tools.

The finished product : high temperature jet engine combustion chambers for the General Electric J-47 jet power plant. They are fabricated from Inconel Metal and seam and spot welding are used to join the assemblies.

Fighters for NATO*

In the middle of February the Canadian Government announced that Canada, the United States and Great Britain had completed arrangements for the pooling of resources for the manufacture, equipment and manning of *several hundred North American F-86 "Sabre" jet fighters for NATO defence*. Under these arrangements Canada will supply the airframes, the USA the engines, and Britain the pilots. The airframes will be built as part of Canada's share in the Mutual Aid Programme at the plant of Canadair Ltd., of Montreal, which is already producing the same basic type for the Royal Canadian Air Force. The Canadian-built airframes will be shipped to the USA to receive their engines and equipment, which will be financed with U.S. mutual defence pact funds. Finally, the completed aircraft will be sent to Britain to be manned by RAF personnel. The number of aircraft involved was not disclosed, but it was stated that this would run into "some hundreds." About a year ago it was reported that the RAF was anxious to obtain between 400 and 500 of the machines.

Only a few days after this announcement, on February 17th, U.S. Air Force headquarters in Washington stated that the USA had placed an order with Canadair Ltd., for a "large number" of F-86 jet fighters. The Canadian company, licenced in 1949 by North American Aviation Inc., had promised early delivery. As in the case of the aircraft destined for the RAF, the USA will provide power plant, instruments and other equipment. One of the conditions of the USAF contract is that aircraft will be supplied to it from the production lines almost immediately, as they are intended for the Korean war. Since Canadair is building the F-86A for RCAF and the F-86E (first version with the so-called "all-flying tail") for the RAF *and* for the USAF, it seems that RAF deliveries might suffer.

The first of the two announcements finally clarifies a rumour which has been going the rounds in different versions since the end of 1950, when the RAF was reported to be studying the possibility of buying "Sabres." Both spotlight a number of interesting aspects :

(1) *U.S. fighters supplied under the Mutual Defence Pact now seem to have been standardized on two modern types :* Republic F-84 "Thunderjets" for Continental Europe and North American F-86 "Sabres" for the USA, Canada and Britain.

(2) *The supply position for medium-power jet engines in the USA has vastly improved in the past twelve months :* a year ago tentative plans still called for the use of Avro "Orenda" or R.R. "Avon" engines in the Canadian "Sabres" to circumvent the then pressing shortage of General Electric J-47 turbojets. Meanwhile, the "Avon" has become practically unobtainable owing to its selection for the British Hawker P.1067 and Vickers-Supermarine "Swift" fighters, the Vickers "Valiant" bomber, the D.H. "Comet 2" transport and several other types, in addition to the big English Electric "Canberra" programme.

(3) *The plan to supply the RAF with "Sabres" seems to indicate that Hawker P.1067 and "Swift" production is still lagging,* and that at least another two years will pass before these types can be issued to squadrons in any number.

(4) The swept-wing "Swift" and P.1067 were themselves regarded as "interim" types in modification of the RAF's original policy to shift direct from straight-wing fighters ("Vampire," "Meteor") to the delta types, by-passing the swept-wing stage. *It now seems that the "Sabre" will serve as an interim type pending the advent of the "real interim types" . . .*

(5) Finally, the two announcements illustrate the growing importance of Canadair, which in addition to its commitments in the production of RCAF "Sabres," Lockheed T-33 and Beech T-36 trainers, can still undertake to turn out substantial numbers of RAF and USAF "Sabres" within a reasonable period of time. "Sabre" production now seems to be about one aircraft per day, and by the end of last February something over 200 had been built.

* Based on reports published in *Interavia Air Letter*, the daily international aviation news digest.

Kloten's new terminal building

At the end of February 1952 the Press had the opportunity of inspecting the unfinished structure of the new terminal buildings at Kloten airport, Zurich. Although not started until November 1950, the structure, 490 ft. long and fully 295 ft. deep in the centre, was roofed over at the end of 1951. It should be ready for occupation by next winter.

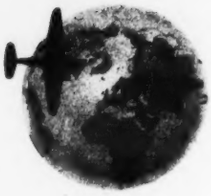
Whereas the airport's runways, taxiways, etc., were built direct by the Canton of Zurich and the Federal Government, with assistance from the cities of Zurich and Winterthur, under control of the Zurich Cantonal Building Directorate, construction and operation of the civilian buildings were entrusted to a mixed enterprise, the *Flughafen-Immobilien-Gesellschaft Zürich,* half of whose capital of 5 million francs comes from public funds. The buildings so far provided comprise an aircraft hangar and a repair shop (both rented to Swissair) and the central building shown here, which will house not only the airline offices, but also the airport administration, air traffic control offices (Radio Switzerland), meteorological service, frontier police, Customs, restaurants and shops. The construction of a mail and freight building and a hangar for sports aircraft is also planned.

The terminal building (architects A. & H. Oeschger) is situated in the south east corner of the airport, between the 8530-ft. instrument runway (QFU 16/34) and the 6230-ft. long "west runway" (QFU 10/28). It is T-shaped and divided into three portions, central passengers' section, office portion with control tower, and restaurant portion. Along the front, on first-floor level, runs a terrace for spectators, 660 ft. long and unusually broad, which also serves to protect passengers going to and from aircraft in bad weather. The building for the most part comprises two storeys in addition to ground floor and cellars, though the north wing has a third storey for the meteorologists, above which the control tower rises to 92 ft. The structure is of strongly reinforced concrete and is built on a foundation of concrete pylons because of the wet, gravelly ground. The control tower is of steel skeleton construction. Cost of construction is estimated at 9,390,000 Swiss francs.

A particularly interesting point is the manner in which passengers, friends accompanying them and sight-seers are separated. A bus brings *outgoing* passengers via a ramp to the spacious main hall, on *first* floor level. Baggage is taken separately, but within sight of the passengers, to the baggage lifts and despatch counters. In the main hall passengers and their friends have an overall view of the airport through five 23-ft. square windows, and the reis a restaurant next door where they can wait until departure time. They then go down a flight of stairs (or by lift) to the ground floor, and pass through passport and Customs formalities into the waiting room, already "abroad" for Customs purposes (this is where transit passengers wait for their next aircraft). Finally, smiling hostesses take them to the aircraft.

Incoming passengers use different parts of the ground floor (except transit passengers, as already noted), passing through passport and Customs shed — where they find their luggage — to the buses waiting to take them, from the *ground floor,* into town. It should also be mentioned that sightseers, to whom the terrace and part of the restaurant are open, never come in contact with the passengers, and that buses and trucks can drive into the cellars if necessary. This means that three floors of the building are accessible to road transport vehicles.

Fifteen hundred outgoing and 1500 incoming passengers can be handled in a hour, which corresponds roughly to the maximum runway capacity.



What's in the Air ? *

AVIATION POLITICS

Pan-European Industry in North Africa ?

● A proposal put forward in Washington by France's Air Minister Pierre Montel that the *nucleus of a pan-European aviation industry* should be developed in *North Africa* (Algeria ? Morocco ?) is of two-fold interest, since it coincides with discussions in the French and German Parliaments on German rearmament. By including the Italian industry—possibly also the German and perhaps even the British—the French North African plant would not only enable vital European production plan to be removed from the "strategic danger zone," but would also help to remove the sting from the restoration of a German aircraft industry. Air Minister Montel stressed however, that the French industry could not be decentralized until the various plants were fully occupied, which was not yet the case.—It will be remembered that two years ago in Paris (April 28th, 1950) Georges Héreil, President of SNCA du Sud-Est, France's most powerful industrial group, created an "*International Aircraft Industry Association*" of pan-European character. (cf. Also Héreil's plans to give European industry sub-contracts in the licence production of the Sikorsky S-55 helicopter by SNCASE : *Interavia* 1952, No. 3).

U.S. Air Bases

● According to reports from Santiago the *United States and Chile are discussing* the possible construction of an American *air base* on the *Easter Islands* (Chilean possessions in the Pacific, some 2,000 miles west of the Chilean coast). Talks have also been begun on the fortification of the Strait of Magellan (strait joining Atlantic and Pacific between Patagonia and Tierra del Fuego). However, Argentine consent must be obtained to the latter project, since the Strait of Magellan is jointly controlled by Chile and the Argentine.

● The *U.S. Senate Preparedness Sub-Committee* has demanded a *thorough investigation of "failures"* in the construction of American *air bases in Morocco*. For example, at Mechra Bel Ksiri considerable work had been done before it was decided to abandon the site because of the danger of flooding. The same applies to a smaller extent to the important base at Sidi-Slimane, and the Nouaceur project (about 18 miles from Casablanca) had proved a "million dollar failure," thanks to the constant flooding of the parking apron.—The arrest of the building chief at the base (Banz) at the end of January and the seizure of the building enterprise's business papers may have something to do with the Senate's move.

New Director General of Civil Aviation in Italy

● *General Alberto Briganti* has been appointed General Pietro Pinna-Parpaglia's successor as *Director General of Civil Aviation* under the Italian Defence Ministry (Air Section). General Briganti is also to replace Army General Armellini, who has reached retiring age, as *Chairman of the Supreme Armed Forces Council*. Interested quarters hope that the concentration of these extensive powers in General Briganti's hands will lead to a thorough reorganisation of Italy's air transportation and ground organization.

AIR TRANSPORTATION

International Organizations

● The major preoccupation of the conference of air law experts convened by the International Civil Aviation Organization's Legal Committee in Paris from January 7th to 21st, 1952, was preparation of the revision of the Warsaw Convention (international agreement on the liability of carriers for damage to passengers, baggage and cargo). The conference, attended by experts from ten countries and presided over by the well-known British air law expert Major K. M. Beaumont, does not appear to have achieved any more tangible results than the ICAO Legal Committee's meeting in Madrid last September. In any case no agreement was reached on the vexed question of the increase in liability limits.

USA

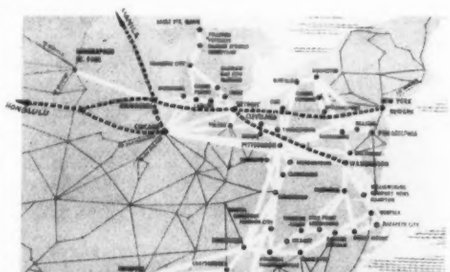
● The *merger* of the two large American overseas airlines, PAA and AOA, appears to have set a fashion which is now spreading—with CAB approval—to the *smaller airlines in the United States*. For example, *Braniff Airways* has applied for permission to take over the smaller *Mid-Continent Airlines*. Both companies fly north-south routes in the Middle West, Mid-Continent being engaged primarily in regional traffic while Braniff Airways also has services to South America.—A more important move, from the economic point of view, is the request to *merge Northwest Airlines and Capital Airlines*. Northwest runs trans-Continental and Pacific services, whilst Capital's network stretches from the Middle West to the East coast and south to Memphis, Atlanta and New Orleans. If the merger of these two companies is approved by CAB, they could together form the *second largest American domestic airline* and the *third largest in Pacific traffic* (after PAA and TWA) with a total route mileage of 28,000 miles. Finally, merger negotiations are in progress between Colonial Airlines, Northeast Airlines and National Airlines.

● A typical example of the complications caused to air transportation by the existence of several control authorities side by side : The Californian Public Utilities Commission is suing Western Air Lines and Californian Central Airlines for $138,000 each for having increased their fares between San Francisco and Los Angeles, *with CAB approval,* but without waiting for permission from the State Commission . . . As a matter of interest permission was granted eventually. But for every day between the raising of the rates and the grant of this permission the airlines are being called upon to pay a fine of $2000. The airlines intend to fight the case, taking it up to the California Supreme Court if necessary.

Great Britain

A preliminary *British European Airways* report for 1951 gives the Corporation's loss for the year as £1,260,000 (compared with £952,500 for 1950). This considerably larger deficit is all the more surprising since the number of passengers carried increased by 100,000 and operating revenue by roughly £2,000,000.

Policy of amalgamation in American air transportation : The north-south routes of Braniff Airways and the smaller Mid-Continent Airlines could be combined, by the merging of the two companies, to form a homogeneous network in the Middle West and East of the United States. (Right : Braniff routes ; left : Mid-Continent routes.)



A merger of Northwest Airlines and Capital Airlines would make the new company into the second largest domestic airline and the third largest on trans-Pacific services. (----- Northwest ; white : Capital.)

Raymond Vanier, Inspector-in-Chief of Air France and head of the "Centre Postal Métropolitain" has been made Commander of the Legion of Honour. Vanier, who opened up a number of routes in Africa and South America, is the only pilot of Air France's 1919 intake who is still flying.

Wilhelm Koele, a Dutch immigrant farmer, risked his life to save two RCAF students when their trainer crashed and caught fire on his farm at Exeter (Ontario). Koele receiving the Netherlands civil award for conspicuous bravery from the Netherlands Ambassador to Canada, Mr. A. H. J. Lovink, during a dinner at RCAF Station, Rockcliffe.

* Extracts from "Interavia Air Letter," daily international news digest in English and French. All rights reserved.

MD 450-30L experimental version of the Dassault "Ouragan" single-seater fighter.

According to Chief Executive Peter Masefield the loss was due to delays in the delivery of new aircraft (Airspeed "Ambassadors," Elizabethan class) and in the conversion of old types (Douglas "Dakotas" into "Pionairs") : £610,000 ; increase in costs : £850,000 ; the "go-slow" strike in July 1951 : £150,000 ; shortage of pilots : £100,000 ; increase in unproductive flying following the introduction of the new "airways" : £110,000 ; fog towards end of season : £30,000.—Be that as it may the British public was doubtless unpleasantly surprised, seeing that BEA had previously announced a profit for the summer months.

● On the other hand *British Overseas Airways Corporation* has announced a surplus of £505,000 for the period April to December 1951, compared with a deficit of £3,157,000 for the corresponding period of 1950.

Ground Organization

● The Dutch Government has decided to build a new concrete runway 6,000 ft. long at Ypenburg airport, near The Hague. This will make Ypenburg into a Class E international airport (suitable for all civil and military aircraft), and the so-called "Schieveen Plan" for a new airport near Rotterdam has been definitely shelved. The Government explain that it will be more economical to expand Ypenburg, which is also more suitable for military aircraft and is only about 16 miles from Rotterdam.

INDUSTRY

USA

● Activity in the West Coast aviation industry during 1951 topped that of all others in the region. Aircraft firms in the Los Angeles area invested no less than $ 126,930,000 in new plant and expansion of old plant, an increase of 1,174 % over 1950. The area's petroleum industry took second place with an expenditure of $ 82,000,000.

● In contrast to this expansion of production capacity, a number of firms have reported that contract completion dates have been extended, in some cases to 1955-56. The reason is lack of engines, propellers and electronic equipment. If production continued at the old rate there would be a risk of hundreds, or perhaps even thousands of finished airframes waiting for equipment. However, managements assure workers that no lay-offs are planned. Hiring will even continue, on a limited scale, although many workers will have to change over to different kinds of work.

● The United States Defense Department has disclosed that its present production goal for engines covers 251,000 jet power plants.

U.S. Air Force Procurement in Europe

● The U.S. Air Force held an exhibition in Frankfurt from January 28th to February 2nd of the items of equipment which it is considering purchasing from European manufacturers. The list includes life-boats for aircraft ; photographic equipment ; fire extinguishers, pumps, vehicles, telecommunications equipment for airports ; tyres and inner tubes ; aircraft parts, propellers, brakes, wheels, seaplane floats ; electrical equipment ; turbojets ; hydraulic shock-absorbers ; deicing equipment ; oxygen masks and pressure suits ; spare tanks ; navigation instruments ; automatic pilots ; pre-fabricated hangars and huts : radio equipment : iron and non-ferrous metals ; chemical products ; office equipment.—The questionnaires provided were filled out by 5,000 firms. The address of the procurement office is *Industrial Planning Division, 7000th Base Complement Squadron, Buchschlag, near Frankfurt, Bahnhofstrasse 8.*

Germany

● The new *Bundesverband der Deutschen Luftfahrtindustrie* (Federal Association of the German Aircraft Industry) established in October 1951 as successor to the pre-war Reichsverband der Luftfahrtindustrie (Reich Aircraft Industry Association), has its provisional headquarters in Stuttgart. Hon. Chairman : ex-Rear Admiral Lahs ; Executive Chairman : Dr. Jastrow ; the committee includes the following members : Prof. Ernst Heinkel, Prof. Claudius Dornier, Franz Popp (Bayrische Motoren-Werke), Siebel, Aug. Mühlen (formerly with Junkers).

FLYING EQUIPMENT

● The U.S. Air Force's procurement programme for 1952-53 includes the quantity production of three new jet fighters :

North American F-100
McDonnell F-101
Convair F-102

The F-100 is a larger and heavier development of the F-86 "Sabre" with more sharply swept wings (45° compared with 35° in the F-86). The power plant to be fitted is the Pratt & Whitney J-57 of 10,000 lbs. thrust.—The F-101 is a development of the McDonnell XF-88 "Voodoo" twin-jet long-range fighter, whilst the F-102 is the production version of the Convair XF-92A experimental delta wing type.

● The first production models of the *Republic F-84 G "Thunderjet"* single-seater fighter are now being delivered to the U.S. Air Force. As is known, the "G" version of the "Thunderjet" is equipped for flight refuelling. The greatly increased endurance and range of this type is illustrated by the fact that a F-84 G recently stayed up over Edwards Air Force Base (California) for 12 hours 5 minutes, being refuelled four times during this period. Each refuelling took 2½ minutes. Two other F-84 Gs flew the 2350-mile distance from Edwards AFB to Langley Base (Virginia) non-stop there and back. Single refuelling over Albuquerque (New Mexico).

● *North American Aviation Inc.'s* 24th Annual report includes a sketch of a *canard type jet-powered delta wing aircraft.*

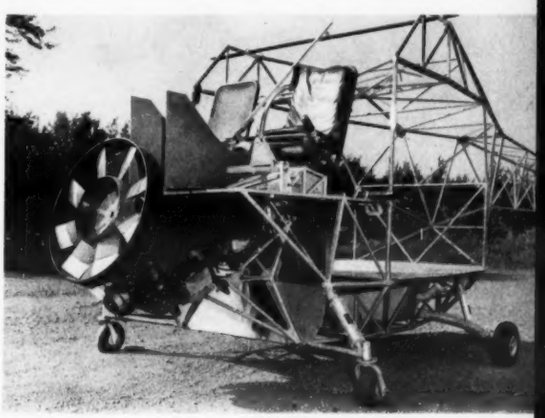
● North American's Columbus (Ohio) plant has delivered the first *AJ-2P "Savage"* for flight testing. The AJ-2P is the photo reconnaissance version of the *AJ-2* (itself a development of the AJ-1 "Savage" carrier-borne attack aircraft) and is said to have a grossweight of some 25 tons. Like its predecessor, the AJ-2P is fitted with two reciprocating engines and one turbojet (Pratt & Whitney R-2800 "Double Wasps" plus Allison J-33). Maximum speed is given as 425 m.p.h.

● A substantial number of *Convair C-131A* twin-engined transports is said to be on order for the U.S. Air Force. No details have been released apart from the statement that the C-131A is a transport version of the T-29 trainer.

● The *Doman Helicopter Inc.*, of Danbury (Connecticut) has completed the prototype of the *LZ-4A* multi-seater helicopter and started its flight testing. The new helicopter has a four-bladed main rotor and a three-bladed tail rotor. As in earlier Doman designs, the engine is mounted in the nose of the fuselage at an angle of 20° to the latter's longitudinal axis.

France

● *Dassault MD 450 Type 30L* is the designation of an experimental version of Marcel Dassault's well-known "Ouragan" jet fighter. It is to be used to try out the air intakes in the sides of the fuselage (the standard "Ouragan" has a central air intake in the fuselage nose), such as will probably be used in the MD 453 "Mystère" two-seater night fighter. This leaves the nose free for the installation of search radar and radar sights. The MD 450-30L is now undergoing flight tests.



Framework of the Doman LZ-4A multi-seater helicopter. The engine, which has a large cooling fan, is installed underneath the pilot's seat.

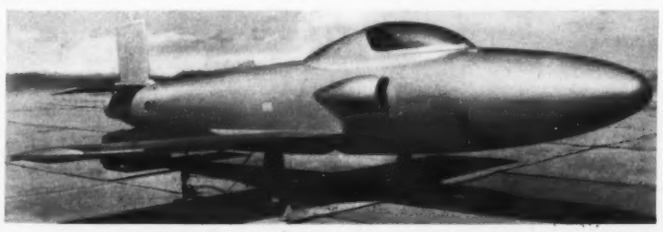
Australia

● An *unmanned jet-powered target aircraft* is being tried out at Woomera Rocket Range in South Australia. The machine was built by the Government Aircraft Factories, of Fishermen's Bend, near Melbourne, to British Ministry of Supply specifications. Before the unmanned model was made, flights were carried out in a manned prototype to test the remote control equipment. This model was fitted with an Armstrong-Siddeley "Adder" jet engine. The unmanned prototype has an A.S. "Viper" engine—an expendable version of the "Adder." It has no undercarriage. Take-off is from a trolley. If the target is not shot down it lands on a skid underneath the fuselage.

Italy

● *Aeronautica Macchi* is working on the *Macchi M.B. 324* jet-powered single-seater fighter with swept wings and tail surfaces. No details are yet available, though the M.B. 324 is said to be capable of "very high subsonic speeds."

Manned prototype of the target aircraft developed by Australia's Government Aircraft Factories. Fitted with an Armstrong-Siddeley "Adder" jet engine, the machine has lateral air intakes . . .



. . . whereas the air intakes in the unmanned version have been placed on top of the fuselage. Dimensions of both models are identical : span 20 ft., length approx. 22 ft.

Book Reviews

Marin la Meslée, by M. Mohrt.—Editions de Flore, Paris, 1951.

Although Mr. M. Mohrt did not personally know Marin la Meslée, he has nevertheless succeeded, by questioning his family, friends and companions in arms, and by studying his squadron's logs—the famous 1/5 Fighter Squadron—in painting us a vivid picture of the personality and character of this ace French fighter pilot. The book also gives the atmosphere in which Marin la Meslée lived—the phony war, the campaign of May and June 1940, retreat and waiting in North Africa, reconnaissance after 1942 and finally the active participation of French air units in the war. Many books have been written about flyers, but few have the scope and depth of *Marin la Meslée.* *Rb.*

Le Destin des Equipages, by P. Mariage.—Librairie Plon, Paris, 1951.

Using the same imaginary characters as in *La Passion des Equipages,* Mr. Mariage now gives us in his new book an account of the various activities of the members of his reconnaissance squadron between the Armistice of 1940 and the eve of victory. The book is interesting in that it reveals clearly the problems which faced the aviators during this period and the ways in which their temperament and resources led them to solve them. *Rb.*

Air Transportation Management, by Joseph M. Nicholson. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Ltd., London.

Since the end of World War II there has been a spate of books dealing with the economics of air transport. It might then be asked whether it was worth writing yet another. The answer must be yes. The author has wisely limited his subject, or rather he has really kept to his subject. In trying to "begin at the beginning" the majority of books on air transport economics succeed only in giving a compressed history of aviation in general, an inevitably patchy outline of technical developments, accompanied perhaps by a brief glance at military aviation, etc.—Nicholson, however, a practical man of wide experience in air transport operations, addresses himself direct to the reader who wants to know how airlines are run, whether it is a good idea to invest money in air transport, why he should entrust himself or his goods to an aircraft. The book is not illustrated, though the text is supplemented by well-chosen statistics and tables. A particularly welcome feature is the short chapter on the running of helicopter companies... The author has played a considerable part in the development of this latest branch of air transport. (English.) *He.*

Marshal without Glory, by Ewan Butler and Gordon Young.—Published by Hodder & Stoughton, London.

The title of this English biography of Goering is well chosen. But whether anyone—in England or elsewhere—is really still interested in reading 277 pages about Goering is doubtful. Nevertheless it must be admitted that the writers have succeeded in discovering new facets to their much-discussed subject (did you know, for instance, that Goering repeatedly described himself to his Allied interrogators as a "Renaissance" character ?).—The book is entertainingly written, but makes no claim to be a historical document. (English). *He.*

95 Fois le Tour du Monde, by Charles Lechevalier. Published by Editions du Seuil, Paris, 1951.

One of Air France's oldest flight captains here tells of his life as a pilot : first Blériot flying school (1922), then No. 1 Fighter Regiment at Thionville (in those days "Spads" and "Nieuports" were still being flown) and a bomber squadron (of Farman 50s) at Chartres.—Lechevalier then became a commercial pilot with *Latécoère-Aéropostale* on the Dakar—Casablanca night mail run. Here he flew the single-engined Latécoère monoplanes which took over the South American mail from the four-engined Farmans at Dakar, and experienced his first breakdowns, including an emergency landing in the desert. He also saw the beginnings of wireless telegraphy and instrument flying. In 1933 he joined the *Air Union* air transport company. There were more emergency landings and alightings, but all had happy endings. In 1934 a number of companies united to form *Air France* and Lechevalier became one of the latter's first pilots. Then came the Spanish civil war and the author flew his company's last services into beleaguered Madrid. Before the outbreak of World War II he was again flying the Casablanca—Dakar—Natal South Atlantic run. A brief period as reserve lieutenant in the *Armée de l'Air* at Lyons, then Armistice, demobilisation... Lechevalier returned the North Africa : "It's useless to fetch me or expect me to come, I'm demobilised—I'm going home. Regards."

But inactivity did not suit him. He got to England via Gibralter, and then to Canada. There he became a pilot in the RAF Ferry Command, in Montreal, and flew a number of B-25 Mitchells to England. He describes several anxious moments during these hazardous flights, for instance an emergency approach to Blue West (Greenland) necessitated by trouble in the fuel system, and an emergency landing, internment and "escape" from Ireland. Back with *Air France* after the war, he experienced the most serious "incident" of his flying career, a fire on board a "Constellation," loss of a propeller, failure of both starboard engines. All this with a crew of 10 (plus pupils), six passengers and diplomatic mail on board... The crew managed to put the fire out and Lechevalier, using all his skill and energy, flew limping on another three hours at under 150 m.p.h. to Casablanca. He even succeeded in getting the undercarriage down, although it had been damaged by the fire... Passengers, crew, mail and aircraft had been brought safely to their destination. (*Interavia* gave a detailed account of this dramatic episode at the time ; cf. "Fire on Board," *Interavia,* Review of World Aviation, March 1947).

Charles Lechevalier, today 48 years old, will go on flying as "seul maître après Dieu" as long as it pleases God. He closes with the words : "I pray that my wings may carry me for a long time yet. When they are tired, my heart will be rich in the visions which enliven the memories of airline pilots." (French.) *Ri.*

Zeitschrift für Luftrecht, edited by Dr. jur. Alex Meyer, Head of the Air Law Research Centre of the University of Cologne. Published by Carl Heymann, Berlin.

Germany still has no air law of her own. But she does have a German air law periodical. It is published by one of the most highly-esteemed legal publishers of pre-war days and edited by an air law expert of note. The first issue is naturally devoted primarily to non-German problems. (German.)

La Convention de Varsovie, by Albert Rabut. Published by Librairie Générale de Droit et de Jurisprudence, R. Pichon et R. Durand-Auzias, Paris, 1952.

Both author—lecturer in air transport at the University of Paris and Inspecteur Principal to Air France—and publisher (who for many years have given particular attention to air law) have acted upon the correct assumption that there was need for publication of the text of the 1929 Warsaw Convention. The battle for the revision of this Convention has broken out all along the line. As many air law and air transport experts as possible should take part in the discussions, so that the new agreement may really meet the needs of modern air traffic. Hitherto the text of the old Convention has been very difficult to get... All this is true. But it is another question whether the author, in commenting on the individual articles of the Convention, has been wise in ignoring altogether recent efforts at revision and the various drafts for a new agreement, for it is this discussion (to which an article elsewhere in this issue is devoted) which makes his booklet of interest just now. (French.) *He.*

Leitfaden der Funkortung, by Walter Stanner and assistants. Elektron-Verlag, Garmisch-Partenkirchen, 1952.

The first comprehensive description of radio navigation to appear in Germany since the war, this well-illustrated (partly in colour) handbook gives the German reader the opportunity to acquaint himself with the developments of the past seven years. The seven chapters deal with : Morphology of radio navigation ; equipment for directional reception (D/F methods, Adcock aerials, radio compass, etc.) ; equipment for directional transmission (Consol, VOR, ILS, etc.) ; hyperbolic chains (Loran, Gee, Decca) ; equipment for distance measuring (Oboe, DME, proximity fuses) ; radar equipment (Freya, Würzburg, Jagdschloss and newer equipment); geophysical and astrophysical problems (solar radiation, radio stars, etc.) Thanks to the cooperation of such outstanding experts as Dr. E. Kramar and A. E. Hoffmann-Heyden (both known to our readers) the author has been able to include many details of German wartime radar developments and of some of the latest advances in the civil aviation field (including the LOMOR system described in the March 1952 issue). (German.) *Ri.*

D. C. Power Systems for Aircraft, by R. H. Kaufmann and H. J. Finison. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Ltd., London, 1952.

One of a series of books on electrical engineering issued by General Electic to promote study of this subject. The book stresses the decisive importance of electrical equipment in modern aircraft construction. Using the minimum of mathematical formulae the authors give a comprehensive theoretical description of the 24-Volt D. C. systems now used extensively in aircraft. The theoretical discussion is supplemented by a section devoted to practical discussion. The wide experience gained by the writers with the General Electric Corp, and the Armour Research Foundation respectively will be of great value to the practical engineer who studies this volume attentively. (English.) *Ba.*

Books received

Publications scientifiques et techniques du Ministère de l'Air.

—Distributed by the Service de documentation et d'information technique de l'Aéronautique, Paris :

Nos. 248, 250 and 251. *Actes du colloque international de mécanique,* Vols. I, II and III.

No. N. T. 42. *Fonctions biharmoniques doublement complexes et applications aux problèmes d'élastostatique,* by Robert Legendre.

No. B. S. T. 115. *Méthode des différences finies appliquée aux problèmes bidimentionnels de calcul des contraintes d'une plaque,* by F. Sakes and C. Thorn.

Fig. 1 : The twin-engined de Havilland D.H. 110 jet fighter has boundary layer fences at the inner ends of the ailerons.

The Boundary Layer Fence

by Dipl.-Ing. WOLFGANG LIEBE

A new device to increase flight safety that has come to the fore in recent years is the boundary layer fence. In the following article an expert on stalling problems from the former Deutsche Versuchsanstalt für Luftfahrt (German Aeronautical Research Institute) describes his first flight tests with this device, and shows how it worked. The writer, who is now working in Jugoslavia, was named as co-inventor, with the DVL, of the boundary layer fence, patented in Germany under the number DRP 700625. We hope the article may give rise to discussion. Stalling, it is true, concerns only the less sensational, lower end of the speed scale, yet the alarming number of fatal crashes due to stalling—25 to 50% of all fatal civilian accidents—illustrates the gravity of the problem. It is a problem which, far from having been solved, has not yet been tackled with the requisite energy. *Editors.*

It was the summer of 1938. We were working on the landing qualities of the Messerschmitt Me 109. The problem was so to improve the aircraft that it could be landed safely without its troublesome slots. Up till then it had been dangerous in slow flight with slots blocked, because the air flow over large parts of the wing began to break away on one side, causing the aircraft to bank abruptly. Slight twisting had moved the centre of the disturbance to the wing root, but this did not improve stalling behaviour. The twisted wing behaved even more unpleasantly than the original wing.

This unexpected result was explained when the film taken during flight was studied. This showed the behaviour of thin silk threads stuck to the wing and thus the processes taking place in the flow layers next to the wing. It was found that the disturbance, which was at first restricted to the wing root, spread astonishingly fast—and on one side only—to the wing tip. The aircraft was suddenly thrown over on to its side, with the pilot helpless to prevent the movement, which set in without warning. The rapid loss in lift was accompanied by a sideways flow of the boundary layer. In particular a cross flow formed at the leading edge, where it was recognizeable on the threads running at right angles to the direction of flight (fig. 2).

The question now arose of whether this intensive cross flow was merely a secondary phenomenon or whether it was to be regarded as the actual cause of the sideways breakaway process. To solve this problem low metal walls were added to the wing, at right angles to the sideways flow observed, to stop the flow.

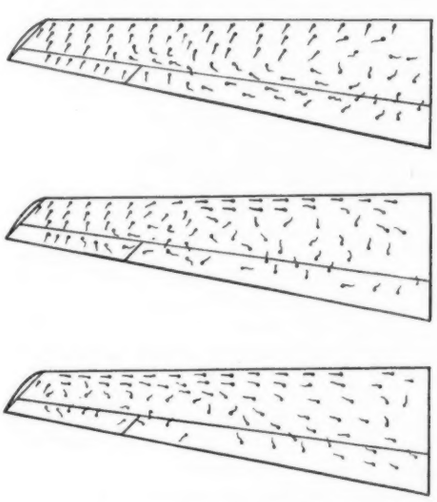
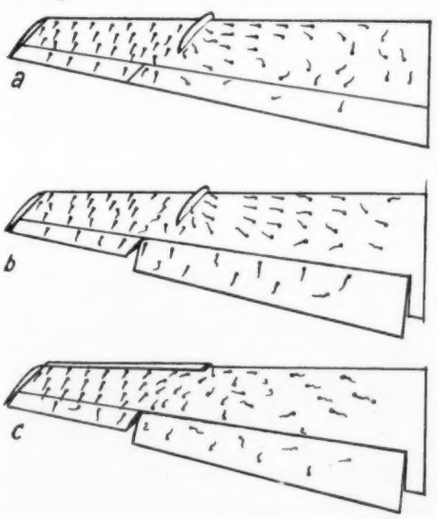


Fig. 2 : Reconstruction of three thread diagrams (at intervals of 0.5 secs.) showing striking flow processes during stalling of a Messerschmitt Me 109 with experimental twisted wing but without slots. The position of the silk threads betrays a rapid sideways spread of the initial disturbance, accompanied by strong cross flows in the boundary layer.

The pilots smiled when the aircraft, the fastest in the world at that time, came taxying out of the hangar with these curious metal ears. Only when they were assured that this was an important experiment, would they consent to fly the machine. The effect produced by this make-shift device was astonishing. The sideways boundary layer flow reached only as far as the barriers. And—even more important—the loss in lift which had previously affected practically the whole of the wing, stopped short at the metal walls. Beyond the barriers there was no cross flow and no more disturbance in flow. The silk threads in the direction of flight lay flat (figs. 3*a* and *b*). And even during a long period in near-stalling flight with the elevator fully deflected the parts of the wing beyond the barriers were undisturbed, whilst the inner regions had marked turbulence and a constant cross flow.

Fig. 3 : Flow on the same Me 109 fitted with boundary layer fence : A *shows landing flap and aileron in normal setting,* B *in landing setting (flap deflection 40°, aileron deflection 15°). The metal fence holds up the cross flow and prevents the spread of the disturbance. —* C *shows the flow on a Me 109 with original wing, with slots open and landing flap and aileron in landing setting.*



The experiment had thus proved that the cause of the cross flow was connected with that of the progressive loss in lift. Simply by stopping this cross flow in the boundary layer, without making any changes in the geometry or the flow conditions of the airfoils concerned, the flow, which had previously broken away, could now be kept flat on the outer parts of the wing (at the same angles of attack as before). We had thus found a simple way of influencing the break-away behaviour of a wing in certain cases.

Since the metal barriers were fitted on the wing at the point where, on the original wing, the inner slot end came, the behaviour of the threads was similar to that on the untwisted original wing with slots open (fig. 3*c*). Despite the fact that the threads had the desired appearance, the flying qualities in a stall were still not entirely satisfactory. However, the earlier very strong rolling motion of the aircraft was considerably reduced by the metal barriers, and stalling behaviour thus markedly improved.

Later experiments showed that the roughly ten-centimetre-high walls had no detrimental effect on other flying qualities and that the reduction in maximum speed was negligible.

•

The new device, which was dubbed the " Grenzschichtzaun " (" boundary layer fence "), was not immediately adopted in practice, and it was not until the appearance of the swept wing, which always has a cross flow in the boundary layer, that it was really accepted. A very undesirable quality of the swept-back wing is the premature break-away of the flow in the outer regions, which evidently arises from this outward boundary layer flow. It was therefore obvious that something must be done to brake the cross flow, and thus put a stop to the premature break-away. At first, experiments were made with metal barriers in the rear third of the wing, since it was there that the cross flow appeared to be strongest. Later however the leading edge fence was adopted. The production models of several modern swept-wing aircraft have recently been fitted with this type of boundary layer fence (figs. 1 and 4).

A double boundary layer fence, i.e. a total of four metal barriers on the wing, is used in the Russian MiG-15 jet fighter (fig. 6). Landing qualities are known to have been the critical problem in this aircraft type,

Fig. 4 : De Havilland D.H. 106 " Comet " jet airliner ; two boundary layer fences.

Fig. 5 : SNCA du Sud-Est " Mistral " jet fighter (de Havilland " Vampire " licence).

and it would doubtless not be wrong to assume that use of a boundary layer fence was not originally contemplated, but that it was added later, when flight tests produced unsatisfactory results. In such cases the structural simplicity of the device, which necessitates no modifications to the wing structure, is of particular value.

A boundary layer fence was also used temporarily on an unswept wing, that of the Fairey " Gannet " anti-submarine aircraft. It is not known why it has recently been dropped in this type, after being included in the first production model. (On the other hand the unswept " Vampire-Mistral ", fig. 5, of the SNCA du Sud-Est is now fitted with a boundary layer fence. Ed.)

The mechanics of the sideways spread of break-away have hitherto received little attention [1] and have therefore never been explained. The flight experiments described above showed that the main flow did not begin to break away until it was influenced by the cross flow in the boundary layer. Not all airfoils behave the same way. The reasons why certain airfoils so readily fall victim to this sideways movement, while others stand firm against it, can only be surmised. In any case a certain part is played by the extent of the low pressure zone on the upper surface of the airfoil. Airfoils with highly-developed lift are particularly susceptible, for the powerful suction on the upper surface attracts the inert flow material from the neighbourhood so strongly and takes up so much of it into itself that the inert flow layers next to the surface are no longer capable of conducting the material away to the rear. Thus at this point of the wing the air piles up in the form of an eddy. The flow breaks away although the airfoil at this moment has perhaps not yet reached its theoretical maximum lift. The process then continues sideways along the wing as far as the low pressure extends, and leads to the phenomenon of progressive breaking away.

In the face of this phenomenon, all well-meaning rules for the design of stall-proof wings, all rules for twisting and taper cease to be valid. Wind tunnel tests have shown that even the rectangular wing, normally regarded as quite safe, can become dangerous at such times (fig. 7). As might be expected, loss of lift begins at the root in this type of wing, but then, since the airfoil is susceptible to break-away, spreads like lightning almost to the wing tip. To be sure of avoiding such surprises it would be well to avoid these susceptible airfoils altogether. However, it is precisely the high-performance, high-lift airfoils which are most dangerous in this respect.

The function of the boundary layer fence is to prevent flow into the inert layers near the surface, or to divert it upwards, into

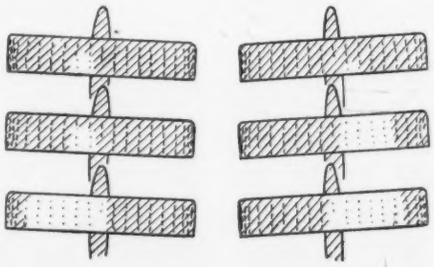
Fig. 6 : Mikoyan-Gurevich MiG-15 jet fighter ; four boundary layer fences.

the layers containing energy which can carry away the material arriving from the side.

This function to be fulfilled by the fence roughly determines its dimensions. It must be continued as far forward on the wing as the area of low pressure reaches. Moreover it must project above the boundary layer, therefore must be higher than the probable thickness of the layer. A number of different heights for the fence were tried out in the experiments on the Me 109. The most effective was found to be a medium height of half the thickness of the airfoil (fig. 8). However aircraft in which the critical processes take place at higher speeds of flight can make do with lower fences.

An interesting example of how the dangerous qualities of an airfoil can be overcome by boundary layer fences is provided by

Fig. 7 : Thread diagram of a rectangular wing with airfoil susceptible to break-away of flow, showing loss of lift on left and right sides. (In these wind tunnel tests the threads were attached to steel rods outside the boundary layer and could not therefore show the cross flow.) The lightning spread sideways of the initial disturbance is clearly recognizable ; the time interval between the pictures (slow-motion pictures) is only 1/50 second.



[1] P. Jordan successfully tackled the problem (cf. " Luftfahrtforschung " 1939/4), and proved with water channel tests the effectiveness of a " dividing ridge ".

experience with the American Emigh " Trojan " light aircraft. The unswept wing of this aircraft is composed of the same airfoil with susceptibility to break-away (NACA 0012-63) as was used for the above-mentioned rectangular wing. Nevertheless the stall behaviour of the aircraft, if we are to believe the reports, was entirely satisfactory. In this aircraft, designed for cheap quantity production, the wing ribs are fitted *outside* the stressed skin wing (fig. 9), and it may be assumed that these cheap outside ribs have a very welcome aerodynamic effect —though one not expressly aimed at by the designer—in that they act as boundary layer fences and reduce the wing's susceptibility to break-away of the air flow.

In swept wings, where the outer wing portions are always piled up with air whose quantity increases with increasing angle of attack, the boundary layer fence can always be useful. In unswept wings full success can be expected only when the incipient break-away process can be isolated by the fence and restricted to a narrow space. In the Me 109 experiments we succeeded in safeguarding the outer wing from break-away. However, over half the wing was affected by the disturbance. (Similar conditions were also probably obtained in the Fairey " Gannet ".) Flying qualities in the Me 109 were therefore not entirely satisfactory. The spontaneous loss in lift up to the middle of the half-wing, where the boundary layer fences were fitted, was sufficient to produce, if not dangerous, at any rate unpleasant rolling. The fence should therefore have been pushed further inwards, so that the middle wing regions were also protected. This however was unsuccessful, since the flow in the middle range of the half-wing began to break away spontaneously, i.e. without any sideways movement by the boundary layer, when the elevator was fully deflected.

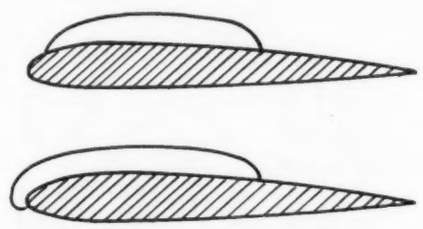


Fig. 8 : Shapes of the boundary layer fence used in the first flight tests of the Messerschmitt Me 109 without slots.

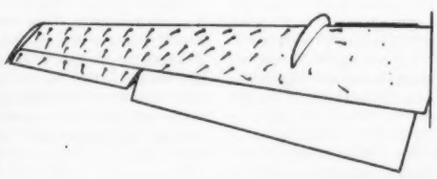
Fig. 9 : Stiffeners on the outside of the wing act as boundary layer fences and give the Emigh "Trojan A-2" sports two-seater satisfactory flying qualities despite the susceptibility of its airfoil to break-away.

Conditions improved only when a *leading edge spoiler* was fitted in the wing root region. The beginning of the break-away could then be shifted, even on the original untwisted wing, so that the disturbance at first occurred only at the wing root. However this disturbance—in particular during crabbing—showed a tendency to spread out sideways. This tendency was completely overcome by placing a fence next to the spoiler (fig. 10). This even gave a decided improvement in flight behaviour, i.e. the previously dangerous aircraft became safe and could now be regarded as " fool-proof ".

Measurements taken in flight confirm this change. The dangerous behaviour of the original wing arose from its marked rolling (fig. 11 left). This motion sets in without warning at a certain angle of attack. The aircraft banks to an angle of over thirty degrees within one second. Such behaviour is unacceptable from the point of view of landing safety, since even the most experienced of pilots could not take countermeasures—supposing that the control surfaces even continued to respond—in time.

When fitted with spoiler and fence the same aircraft on the other hand had unusually good qualities (fig. 11 right). It could be kept for any length of time in near-stalling flight, with elevator fully deflected, without showing the slightest tendency to tip over. A slight wobbling motion set in about all three axes, but the maximum amplitude of this motion—with ailerons blocked—did not exceed roughly ten degrees. With spoiler alone, i.e. without fence, the wing developed far less safe characteristics. After a warning movement the aircraft finally tilted dangerously. A comparison of the two behaviours shows the decided improvement obtained with the boundary layer fence (fig. 12).

Fig. 10 : Me 109 with closed slot, leading edge spoiler and boundary layer fence. The disturbance produced by the spoiler is restricted by the fence to the root area of the wing.



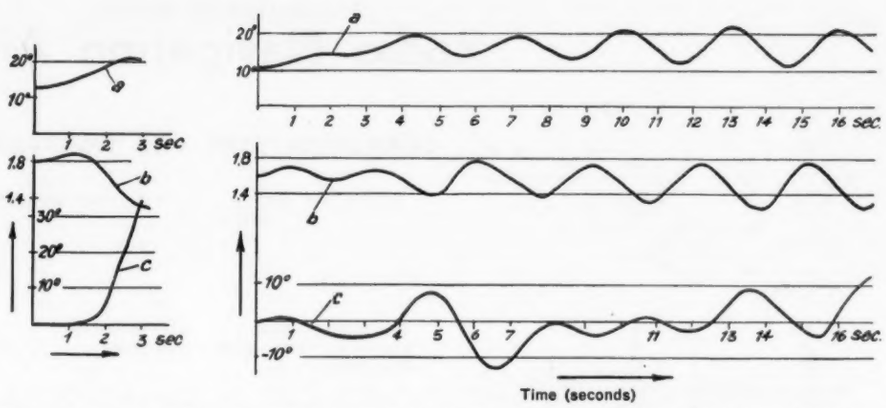


Fig. 11 : Stalling behaviour of a Me 109 with closed slots. Left without, *right* with *boundary layer fence and spoiler. The left-hand portion of the picture shows powerful rolling motion, but in the right-hand portion, in spite of large angle of attack and high lift coefficient, there is no sign of any tendency to tilt over. Wobbling motion is also moderate.*

a = Angle of attack (degrees) b = Lift coefficient c = Bank (degrees)

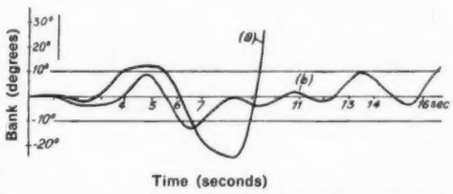


Fig. 12 : Banking process during stall by Me 109 with closed slot : (a) with spoiler alone ; (b) with spoiler and fence.

*

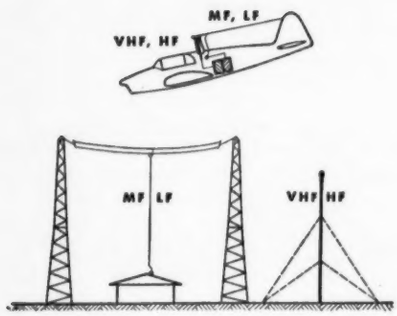
Tests and experience have shown that the boundary layer fence, despite its simple design, can substantially help to increase flight safety. It has therefore won a permanent place in aircraft engineering. But the fence represents only a first step on the road towards the control of secondary flows. Other, more refined devices will follow, to help the designer solve this still knotty problem.

Photo credits :

Front Cover : Radio Suisse ; pp. 184-186 : Interavia Records ; pp. 187-189 : S.A.S. ; pp. 190-193 : Radio Suisse (1), factory photos (2), Interavia Records (4) ; pp. 197-200 : Chester Sharp (1), National Fire Protection Association (1), ATP (1), Interavia Records (1) ; pp. 205-210 : Lockheed (11), Ryan (5) ; p. 211 : Zurich Building Directorate ; pp. 212-213 : Air France (1), Howard Levy (1), RCAF (1), factory photos (5), Interavia Records (7) ; pp. 215-217 : author (7), factory photos (3), William Green (1), Interavia Records (1) ; pp. 218-221 : Interavia Records.

Radio Navigation Aids*

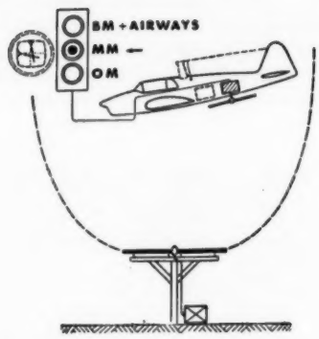
COMMUNICATIONS AND SIGNALLING



1

NON-DIRECTIONAL TRANSMITTERS AND RECEIVERS

Ground transmitters and receivers near airfields ; LF and MF waves usually radiated or received through T-aerials, HF and VHF waves through mast aerials. Airborne transmitters and receivers likewise have T-aerials (or L, V, or retractable trailing aerials) for LF and MF, and mast aerials for HF and VHF waves.

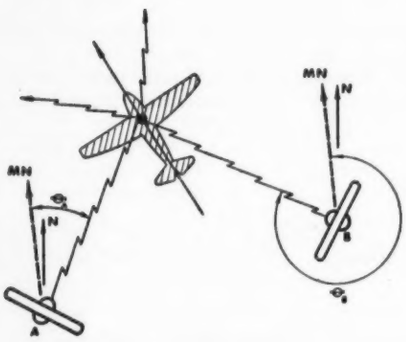


2

VHF MARKER BEACONS

Vertical transmissions from VHF radio beacons (mostly 75 Mc/s) are received in the aircraft as visual and/or aural signals, informing the pilot that he is over a specified point along an airway or approach beam. The Z-marker, in a cone of silence, indicates the location of a radio station.

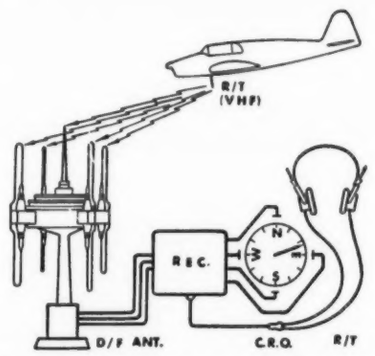
DIRECTION-FINDING



3

GROUND DIRECTION FINDING

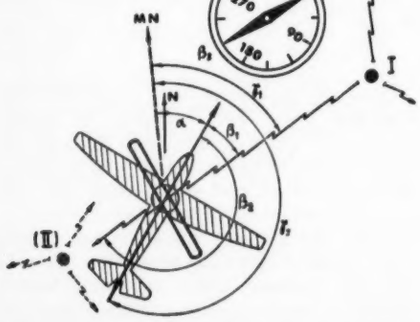
Ground D/F receivers (A and B) take bearings on the airborne transmitter (which has identified itself) by determining the angle between the bearing line and magnetic (MN) or true (N) north, and radio them back to the aircraft, where the fix is plotted. Alternatively, ground stations can plot the fix and radio it to the aircraft. International Q code used in communications.



4

GROUND VHF AUTOMATIC DIRECTION-FINDING

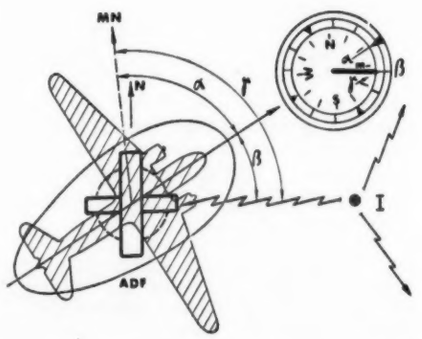
VHF voice transmissions from aircraft are received by airfield receivers with fixed H-type Adcock aerials employing folded dipoles ; direction of incoming waves is continuously indicated on a cathode ray scope. Bearings can thus be radioed from the control tower without delay while voice communications are maintained. Range up to 100 miles.



5

DIRECTION-FINDING WITH D/F LOOP

Airborne equipment comprises D/F loop aerial, rotatable through 350°, and receiver. When receiver is tuned to ground station and loop is set perpendicular to station direction (null position), reception is at minimum or null volume (easier for human ear to catch than maximum). Bearing (β) in relation to longitudinal axis of aircraft is read off from a scale coupled to the loop. Angle (γ) between magnetic (or true) north and bearing line to ground station is the sum of the relative bearing (β) and the aircraft heading (α) with respect to magnetic (or true) north. Readings have 180° ambiguity (hence double pointer) as ground station can be at either point I or II.



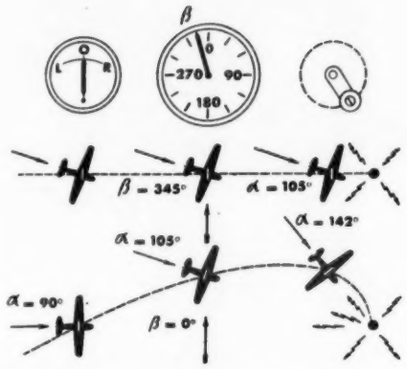
6

DIRECTION-FINDING BY RADIO COMPASS

The RADIO COMPASS provides a unidirectional bearing indication, a sense aerial and a special receiver detecting the direction of origin of the incoming wave, thus eliminating the 180° ambiguity of the simple D/F loop system. The AUTOMATIC RADIO COMPASS has a powered rotating mechanism which automatically turns the loop to null position, irrespective of changes in aircraft heading. Some models have an inner loop to replace the sense aerial ; located perpendicular to the main loop, it gives maximum volume of reception when the latter gives minimum. The ADF indicator has a fixed outer scale and a moveable inner scale, adjusted either manually or automatically to give the aircraft heading (α), thus directly indicating the angle (γ) between the bearing line and north.

[1] *Revised extract from " A Short Guide to Radio Aids used in Air Navigation ", INTERAVIA, Review of World Aviation, Nos. 11 and 12, 1948. For abbreviations used see p. 221.*

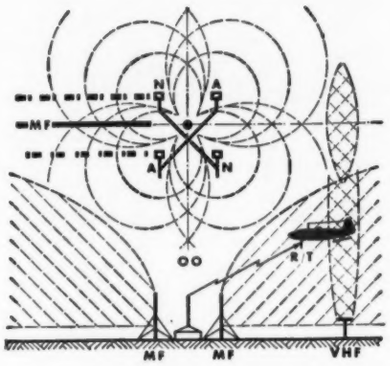
RADIO BEACONS



7

HOMING WITH D/F

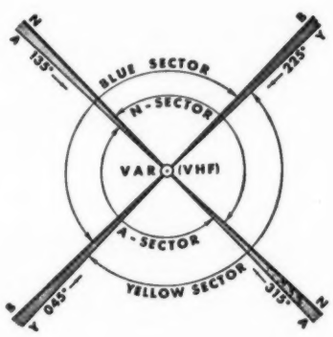
When the D/F loop is set perpendicular to the aircraft's longitudinal axis and the aircraft is steered so that a null signal is always received, the aircraft is heading either to or from the station or radio beacon along a track which is curved according to lateral wind conditions. Off-course derivations are indicated as visual left-right signals and/or as aural A-N morse signals, or else transformed into pulses which are fed direct to an automatic pilot. To compensate drift, the loop can be turned slightly out of null position by setting the null pointer to the downwind side of the aircraft's nose.



8

LF AND MF RADIO RANGE

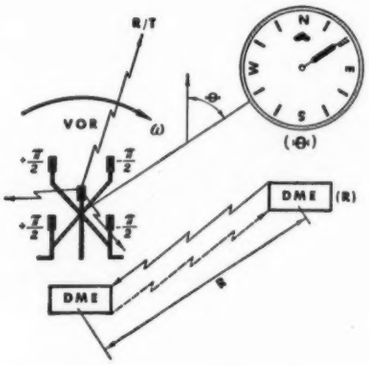
U.S. and Western European method of short-distance navigation along airways marked by a network of LF or MF directional stations ; Adcock aerials systems each send out two A and N beams in interlocking sequence so that a continuous (" on course ") signal is heard in their plane of intersection. Position fixes occasionally indicated by fan markers and M-markers placed at specified points along airways ; R/T usually provided through centre aerial of range station.



9

VHF FOUR-COURSE VISUAL-AURAL RADIO RANGE (VAR)

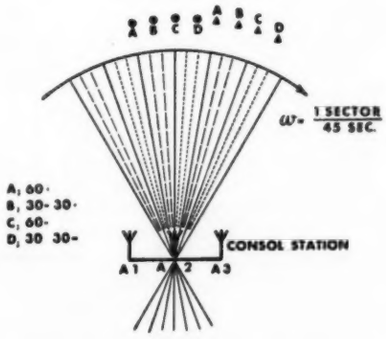
System of VHF transmitting stations which send out aural (A and N in morse) signals along two courses and visual (blue and yellow) signals on the other two ; the latter can be read off from the ILS localizer indicator. The system works more accurately in mountainous regions than the MF range system and forms a transitional aid between the latter system and the VHF omni-range.



10

VHF OMNI-(DIRECTIONAL RADIO) RANGE (VOR)

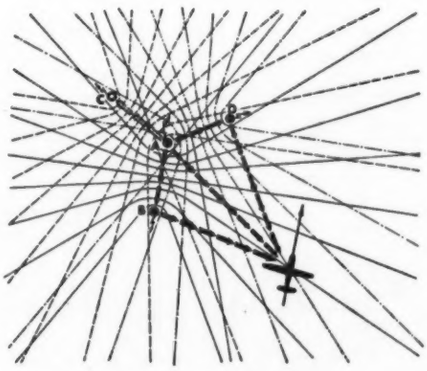
Short-distance navigation system comprising a network of VHF beacons with fast-spinning field pattern, for automatic determination of azimuth (by phase comparison) in the aircraft. If DME (radar) beacons are installed on the ground and DME in the aircraft, distance can also be measured.



11

MF LONG-DISTANCE NAVIGATION BY " CONSOL "

MF " Consol " stations enable very exact azimuth determination to be made with the aid of standard airborne receivers, if the approximate position is first known (e.g. from bearings taken by normal D/F loop). Three aligned aerials emit over two sectors 120 deg. wide and centred on the line normal to the aerials, dot and dash signals (morse E and T) on beams slowly swept by appropriate aerial switching, which are heard and counted in the aircraft, thus enabling the azimuth to be obtained from tables or " Consol " charts. Over-water range, day and night, up to 800 nautical miles ; day error ± 0.2 to ± 1 deg., night error greater.

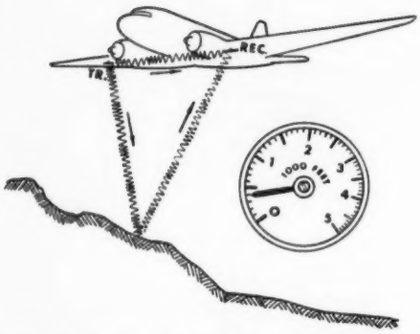


12

LF SHORT-DISTANCE NAVIGATION BY " DECCA "

By measuring the phase difference (in the aircraft) of the transmissions of two synchronized pairs of transmitters of a chain (master transmitter and three slave stations about 110 nautical miles apart) two hyperbolas are obtained (difference in phase corresponds to difference in distance). The aircraft's position is at the point of intersection of these hyperbolas and is found from special maps or by means of an automatic Flight Log, from the readings of the " Deccometers " in the aircraft. Accuracy is very high : Up to a range of 300 nautical miles (over sea) accuracy is ± 3' by day, and ± 15' at night ; navigation accuracy within the chain reaches ± 10 m, and at 300 nautical miles from the master station ± 100 m.

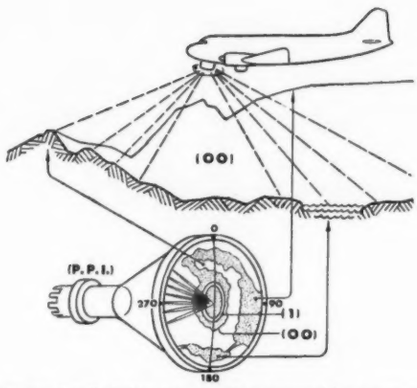
RADAR NAVIGATION



13

ALTITUDE DETERMINATION BY UHF RADIO ALTIMETER

For continuous determination of altitude (ground clearance) frequency-modulated continuous UHF waves are radiated from one of the aircraft's dipole aerials (their frequency being varied linearly between a maximum and a minimum), reflected from the ground and received by the second dipole aerial. The difference in frequency between the transmitted and reflected waves, which is proportional to the ground clearance, is measured by an interference measuring device and indicated in feet on the radio altimeter scale.

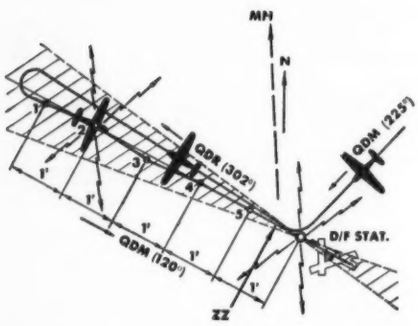


14

POSITION FINDING AND COLLISION WARNING BY SHF AIRBORNE RADAR

The ground outside a cone of silence directly below the aircraft is scanned by a narrow, rapidly-revolving SHF (microwave) beam, and the reflections from the ground, or echoes, are reproduced on a cathode ray scope with a revolving time base synchronized with the aerial. Bright areas on the scope signify strong echoes ; dark areas are " no-signal areas ", indicating a body of water or shadows behind major ground elevations. This gives a rough " shadow picture " of the ground and facilitates position finding. Elevations near the altitude of flight cause strong shadows to appear at the edge of the Plan Position Indicator, thus warning of obstacles. The system can also be adapted to detect storm clouds and other aircraft.

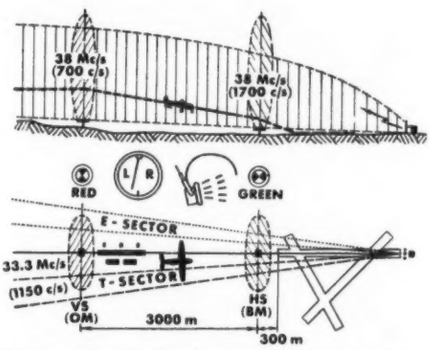
ALL-WEATHER LANDING



15

DESCENT THROUGH CLOUD (AND ZZ)

If ceiling permits, SIMPLE DESCENT THROUGH CLOUD can be made above an airfield or nearby radio beacon, followed by contact approach. If clouds conceal hazardous elevations, the ZZ PROCEDURE can be used for approach to the airfield. Above the airfield the pilot receives the barometric pressure at airfield level (QFE), flies away from the airfield along a prescribed course for a few minutes, turns through 180° and approaches the airfield at a prescribed height ; during this time he continuously emits signals, which the ground D/F station uses to correct his course. Shortly before he reaches the airfield boundary the pilot receives the ZZ signal, then descends till he can see the ground, and lands. In the event of a faulty approach, he receives a JJ signal, meaning that he must interrupt his approach and repeat the manoeuvre.

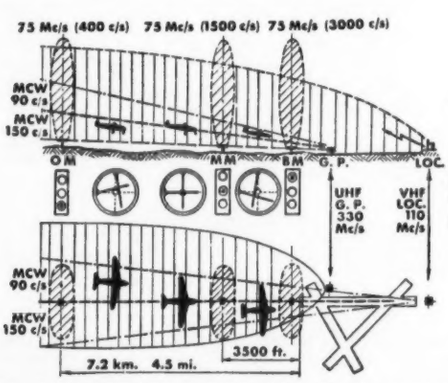


16

INSTRUMENT APPROACH ON ONE BEAM

(Lorenz-SBA, VOR, VAR and RNG)

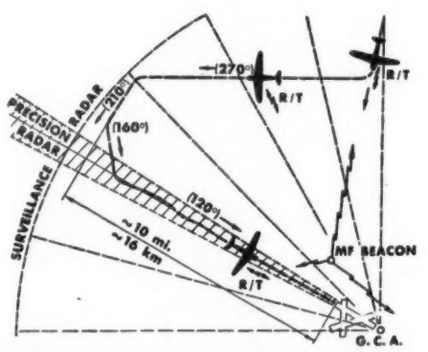
A VHF localiser (or LF, MF or VHF radio range) at the end of a runway emits, in the direction least disturbed by obstacles and side-wind, two beam arrays keyed with E and T A (or and N) morse signals, giving an equi-signal zone in their plane of intersection. In this zone the signal is received in the aircraft as a continuous note ; deviations from this " on-course " zone are shown visually by a left-right indicator and/or aurally by predominant E or T (A or N) signals. Two vertically-radiating VHF marker beacons (in the Lorenz and SBA systems) serve to reveal the aircraft's distance from the runway, since the pilot receives visual and aural signals when he is over them. Also a rough idea of distance can be obtained from the increase in field strength of localiser reception, this being indicated by a pointer instrument. These enable the pilot to keep to the prescribed approach path.



17

VHF/UHF INSTRUMENT LANDING SYSTEM (ILS) ON TWO BEAMS

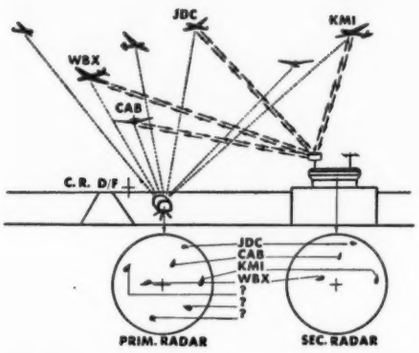
The American ILS (also SCS.51 or CAA System), recommended by ICAO for international adoption, uses two guiding planes to define an approach path. These originate from a VHF localiser situated at the up-wind end of the runway centre-line, and a UHF glide-path transmitter located away from the runway end on a level with the proposed touch-down point. Two pairs of MCW beam arrays, with 90 c/s modulation on one side and 150 c/s on the other, each intersect to define a plane. A cross-pointer instrument indicates the position of the two planes relative to the aircraft ; three VHF marker beacons (outer, middle and boundary markers) record visual or aural signals when the aircraft flies over them, thus indicating the distance away from the runway.



18

UHF/SHF (RADAR) GROUND CONTROLLED APPROACH (GCA)

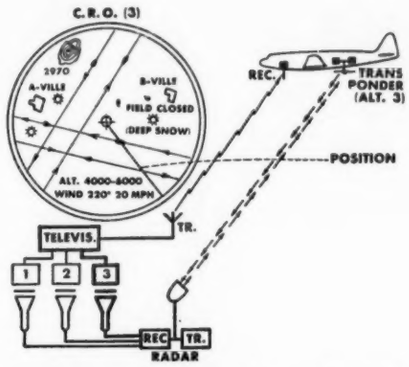
Aircraft within the 30-mile range of GCA's rotating UHF surveillance radar aerial are recorded on a PPI scope. Aircraft desiring to land receive R/T instructions guiding them into the zone of the two SHF precision radar beams which scan the approach sector in elevation and azimuth, and display the aircraft's progress on two scopes ; off-course deviations are communicated by R/T to the pilot. Airborne equipment, in addition to blind-flying instruments, can be confined to a VHF two-way radio to make the " talk-down " procedure possible.



19

UHF/SHF AIRPORT CONTROL RADAR

UHF primary airport-control radar, working on direct reflection of transmitted pulses, scans the zone in airport vicinity, by means of a rotating search aerial, detecting all nearby aircraft and presenting them on a PPI scope. It can be supplemented by a secondary radar set which detects only those aircraft having responders. The rotating aerial of the secondary set transmits SHF pulses which are answered on VHF by the airborne responders; presented on a separate scope, these answers simultaneously give indications of aircraft identity and altitude. An automatic VHF ground D/F set completes the system.



20

UHF/SHF TELEVISION-RADAR AIR NAVIGATION (" TELERAN ")

Projected combined system for air navigation, traffic control, collision warning, etc. The pilot continuously receives simplified pictorial displays for all traffic manoeuvres (taxying, instrument take-offs, flight at different levels, blind approaches and landings) on his own cockpit television scope, thus aiding him to navigate, warning him of obstacles, giving him weather and route reports, etc. Ground search radar scans the entire air space, interrogating all passing aircraft and allocates several specific levels and records the entire traffic situation on PPI scopes ; with transparent charts superimposed showing topography, weather and wind data, etc. the PPI displays are televised to the aircraft.

MOST COMMON ABBREVIATIONS

ACC = Area Control Centre
ACR = Approach Control Radar
ADC = Aerodrome Control
ADF = Automatic Direction Finder
APP (APC) = Approach Control
ATC = Air Traffic Control
ASV = Approche Sans Visibilité = Instrument Approach
BABS = Blind Approach Beacon System (RAF)
BCN = Beacon
BM = Boundary (inner) Marker
BS = Broadcasting Station
CAA = Civil Aeronautics Administration
COM = Communications
CON = Consol
CR.D/F = Cathode Ray Direction Finder
CRT (CRO) = Cathode Ray Tube (Oscillograph)
CTA = Control Area
CW = Continuous Wave
D/F = Direction Finder
DF/CS = Direction Finding Control Station
DME = Distance Measuring Equipment
FIDO = Fog, Intensive Dispersal of
FIC = Flight Information Centre
FIR = Flight Information Region
FIS = Flight Information Service
FM = Fan Marker
FM = Frequency Modulation
GCA = Ground Controlled Approach
GP = Glide Path transmitter
HDF = High-frequency D/F
HF = High Frequency (3-30 mc/s)
HS = Hauptsignal = boundary (inner) marker (of Lorenz landing system)
IFR = Instrument Flight Rules
ILS = Instrument Landing System
IM = Inner (boundary) Marker
L = Compass Locator
LAN = LANding aid
LF = Low Frequency (30-300 kc/s)
LOC = LOCaliser
M = Marker
MCW = Modulated Continuous Wave
MDF = Medium Frequency D/F
MF = Medium Frequency (300-3000 kc/s)
MLS = Microwave Landing System
MET = METeorology
MM = Middle Marker
NAV = NAVigational aid
NDB = Non-Directional (radio) Beacon
OM = Outer Marker
P = Pulse Emission
PAR = Precision Approach Radar
PPI = Plan Position Indicator
PRF = Pulse Recurrence Frequency
RBN = Radio Beacon
RF = Radio Frequency
RNG = Radio Range
RSP = Responder Beacon
R/T = Radio Telephony
RTCA = Radio Technical Commission for Aeronautics
SBA = Standard Beam Approach
SHF = Super High Frequency (3000-30,000 mc/s)
SRE = Search Radar Element
TWR = Tower (Aerodrome Control)
UHF = Ultra High Frequency (300-3000 mc/s)
VAR = Visual-Aural (four-course radio) Range
VDF = Very high frequency D/F
VFR = Visual Flight Rules
VHF = Very High Frequency (30-300 mc/s)
VLF = Very Low Frequency (less than 30 kc/s)
VOR = VHF Omni Range
VS = Vorsignal = Outer Marker (Lorenz landing system)
W/T = Wireless Telegraphy
Z = Greenwich Mean Time
ZM = Z-Marker

LAI *LINEE AEREE ITALIANE*
ROME

ROME - NEW YORK - MILAN - NEW YORK
ROME - TEL AVIV - ROME - ATHENS - ISTANBUL
ROME - ATHENS - ALEXANDRIA - CAIRO
ROME - MILAN - NICE - BARCELONA
ROME - PALERMO - TUNIS

PASSENGERS AND FREIGHT

Information and reservations :

ROME : (Passengers) Via Barberini 24 ; Tel. : 44338 ; Teleg. : « LAIPASS ». (Freight) Via S. Andrea delle Fratte 3 ; Tel. : 60997 ; Teleg. : « RIROS-PEPAS »

MILAN : (Passengers) Via Caserotte 3 ; Tel. : 84941 ; Teleg. : « ITALMAR ». (Freight) Via F. Cavallotti 15 ; Tel. : 790755 ; Teleg. : « LAIMERCI »

NEW YORK : (Passengers and freight) 15 East 51st Street ; Tel. MUrray Hill 8-0331 ; Teleg. : « ITAIRLINES »

and from all travel agencies.

Wanted — AT-6 parts

HARVARD (MARK 4), SNJ OR NAA TRAINER PARTS OF EVERY NATURE

Also : Curtiss C46 & Douglas C47 and C54 Parts.
Also : Complete Above Aircraft Wanted.
Also : Matching Hamilton Standard Parts & Propeller Assemblies.
Also : Pratt & Whitney R1340, R1820, R1830, R2000, and R2800 Engines or Engine Parts.

New or Overhauled & Certified Material OK.
Cable or write immediately !

COLLINS ENGINEERING COMPANY
9050 West Washington Blvd.
CULVER CITY, CALIFORNIA
Phone : TExas 0-4811 Cable Address : JOCOCO

Efficient Ground-handling - Impeccable Service - Reliable Repairs for Charter-Lines and Tourist-Traffic

Certificate of qualification of Federal Air Office

PILATUS AIRCRAFT WORKS LTD., STANS, Switzerland

INTERAVIA

Subscriptions in Great Britain from
INTERAVIA (U.K.), Ltd.,
Standbrook House,
2-5, Old Bond Street,
LONDON, W. 1.

Annual subscription rate : 46/- per year

For your 1951 (Vol. VI) issues of
INTERAVIA REVIEW

our

Binding Covers

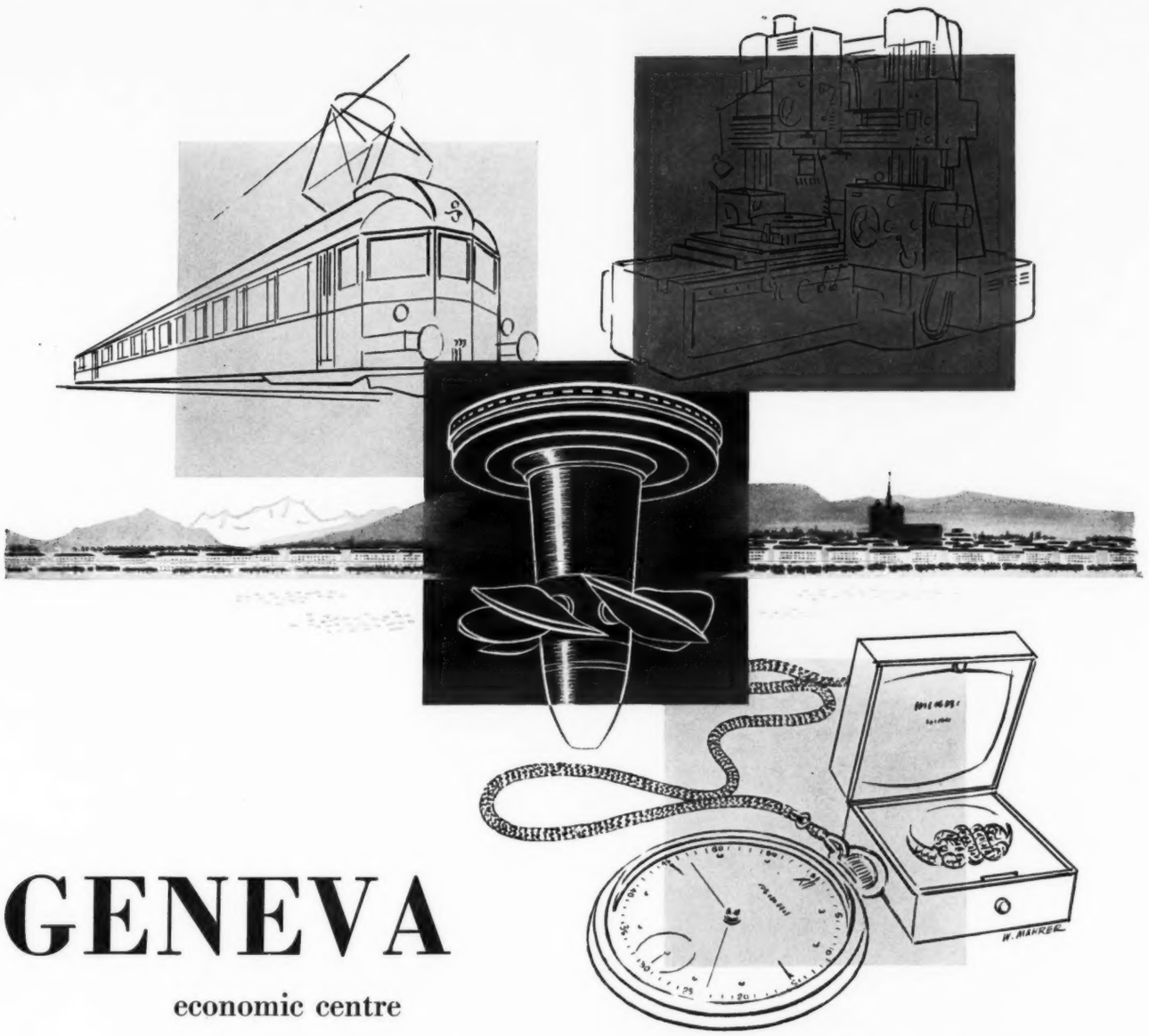
Imitation leather with gold lettering
are now available

Price, including postage and packing :
Switzerland : Sw. frs. 6.50. Foreign countries : Sw. frs. 7.50

INTERAVIA S. A.
6, CORRATERIE GENEVA SWITZERLAND
Swiss postal cheque account No. I. 5380 Geneva

AN ENGINE IN THE INTERNATIONAL CLASS

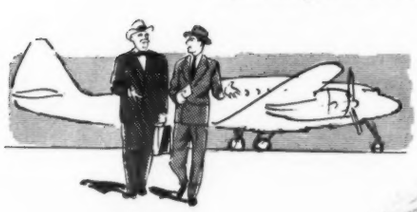
LE POTEZ 6 D

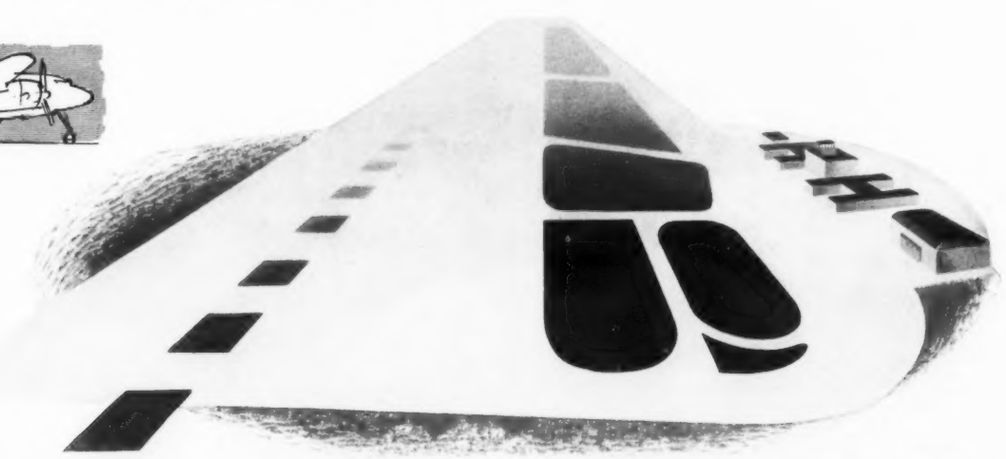


GENEVA

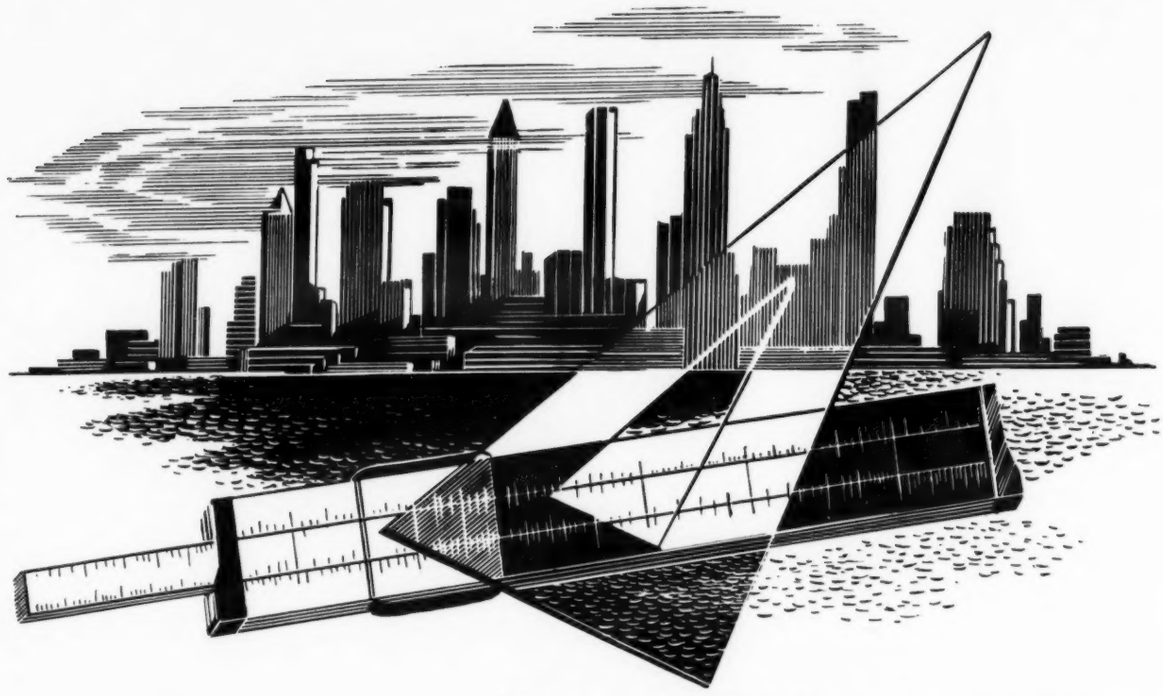
economic centre

city of craftsmen, industry and commerce, international business centre, easily accesible from all parts of the world thanks to its air services.

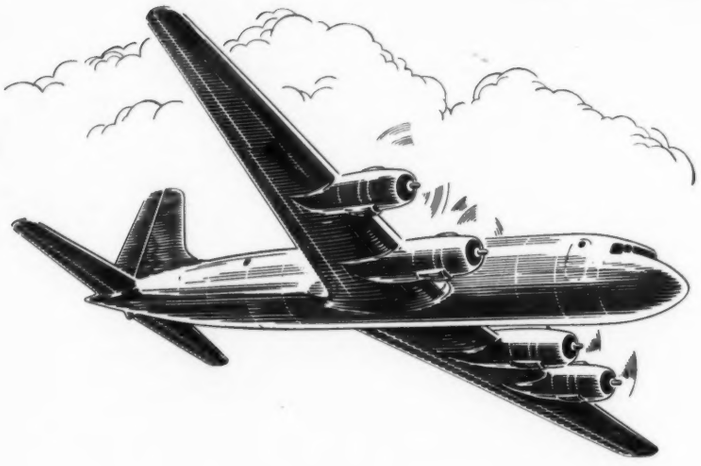




GENEVA INTERCONTINENTAL AIRPORT



He's a world-famous engineer



...he always travels Douglas DC-6

FLY DOUGLAS DC-6

on these leading airlines of the world

AA *Argentine* - **AMERICAN** *U.S.*
BCPA *Australian New Zeeland* - **BRANIFF** *U.S.* - **CMA** *Mexican*
***CONTINENTAL** *U.S.* - ***CPAL** *Canadian* - **DELTA** *U.S.*
* + **FLYING TIGER** *U.S.* - **KLM** *Netherlands* - **LAI** *Italian*
NATIONAL *U.S.* - **PAL** *Philippine*
PANAGRA *U.S.* - ***PAN AMERICAN** *U.S.* - **SABENA** *Belgian*
SAS *Danish Norwegian Swedish* - + **SLICK** *U.S.*
SWISSAIR *Swiss* - ***TAI** *French* - **UNITED** *U.S.*
***WESTERN** *U.S.*

**Soon* + *Air Freight*

Many of these and other world airlines also fly dependable Douglas DC-3s and DC-4s.

Twice as many people fly

DOUGLAS

as all other airplanes combined